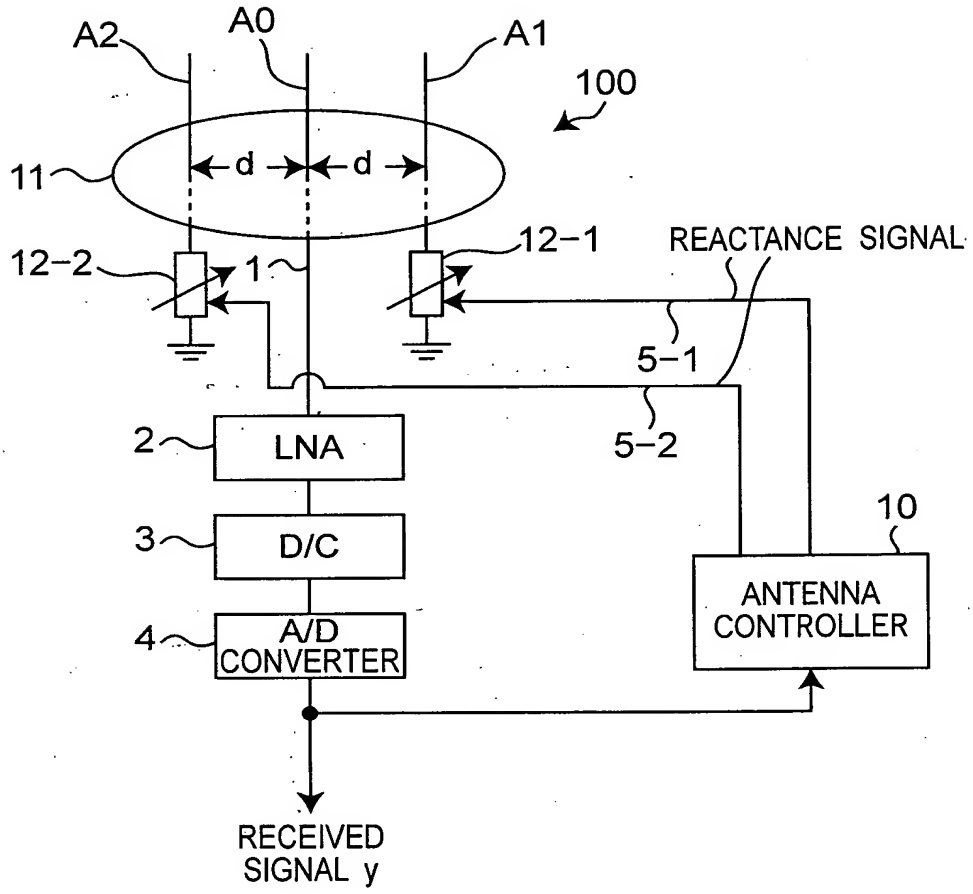
Fig.1


A2
A0
A1
100
11
d
d
12-2
1
12-1
REACTANCE SIGNAL
5-1
5-2
2
LNA
3
D/C
4
A/D CONVERTER
10
ANTENNA CONTROLLER
RECEIVED SIGNAL y

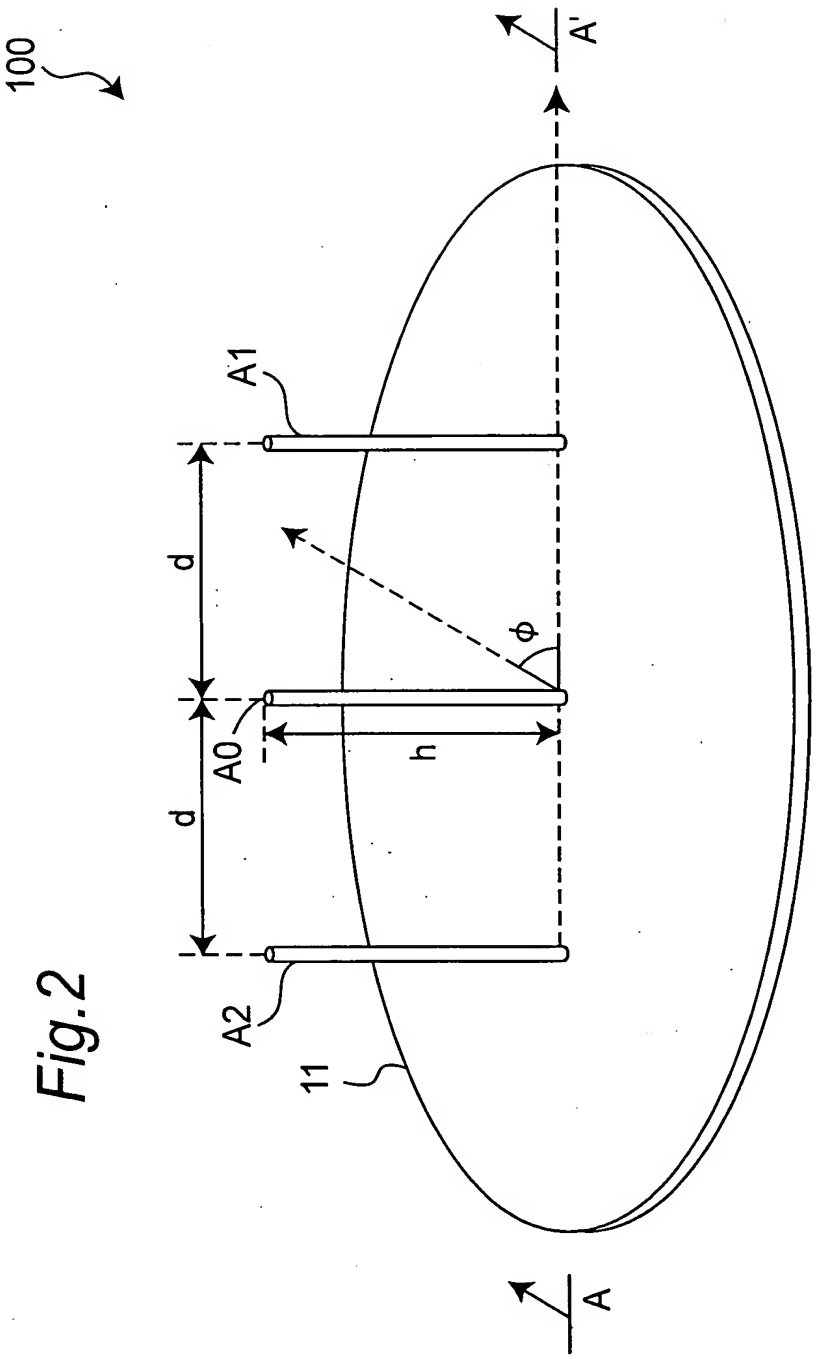


Fig.2

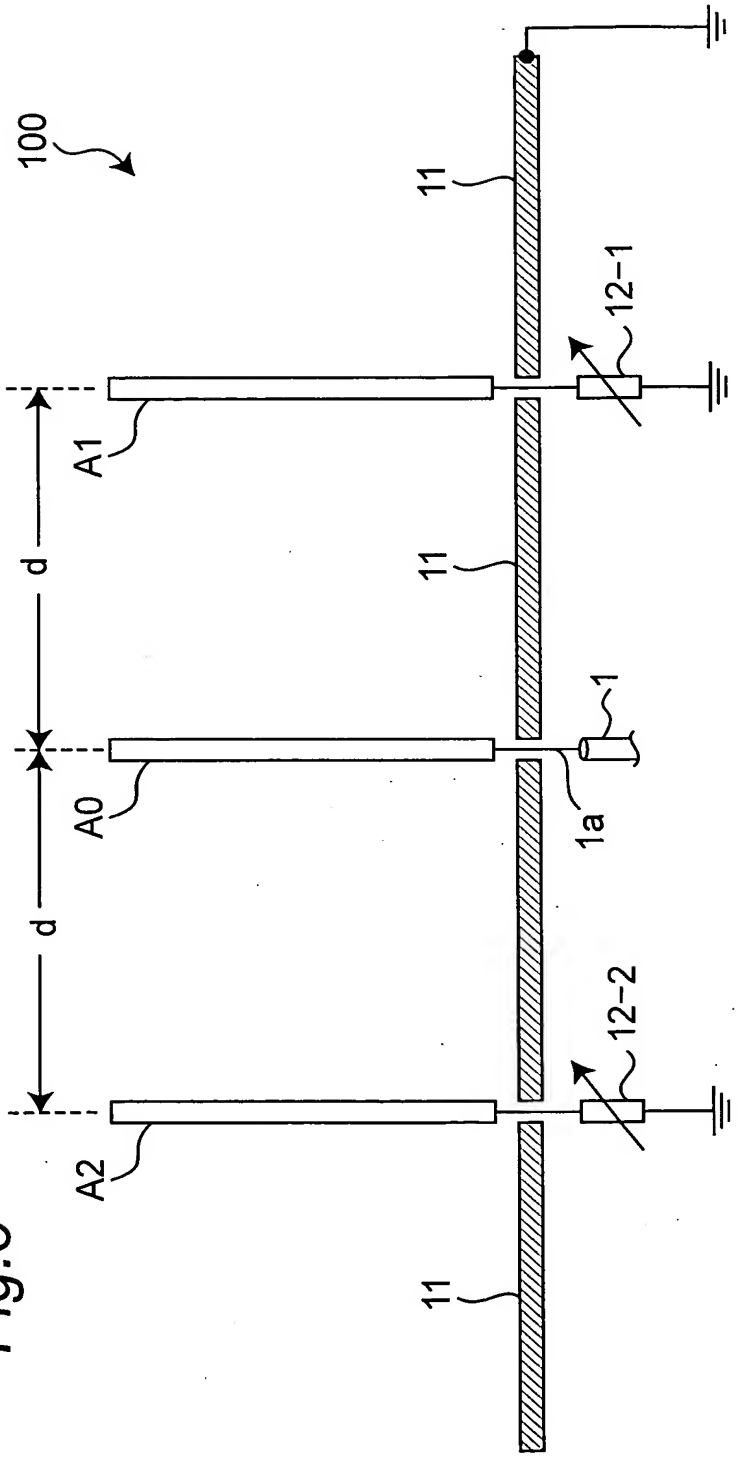
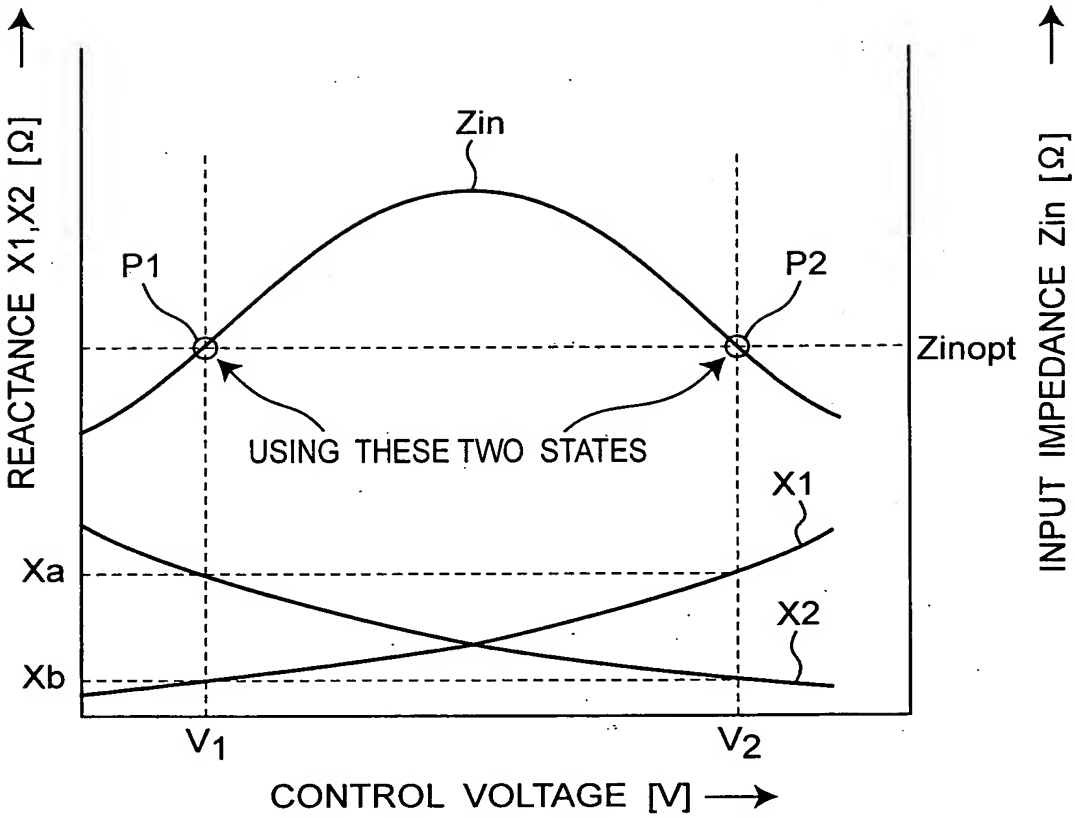


Fig.3

Fig.4


REACTANCE X1,X2 [Ω]
INPUT IMPEDANCE Zin [Ω]
Zin
P1
P2
Zinopt
USING THESE TWO STATES
X1
X2
Xa
Xb
V1
V2
CONTROL VOLTAGE [V]

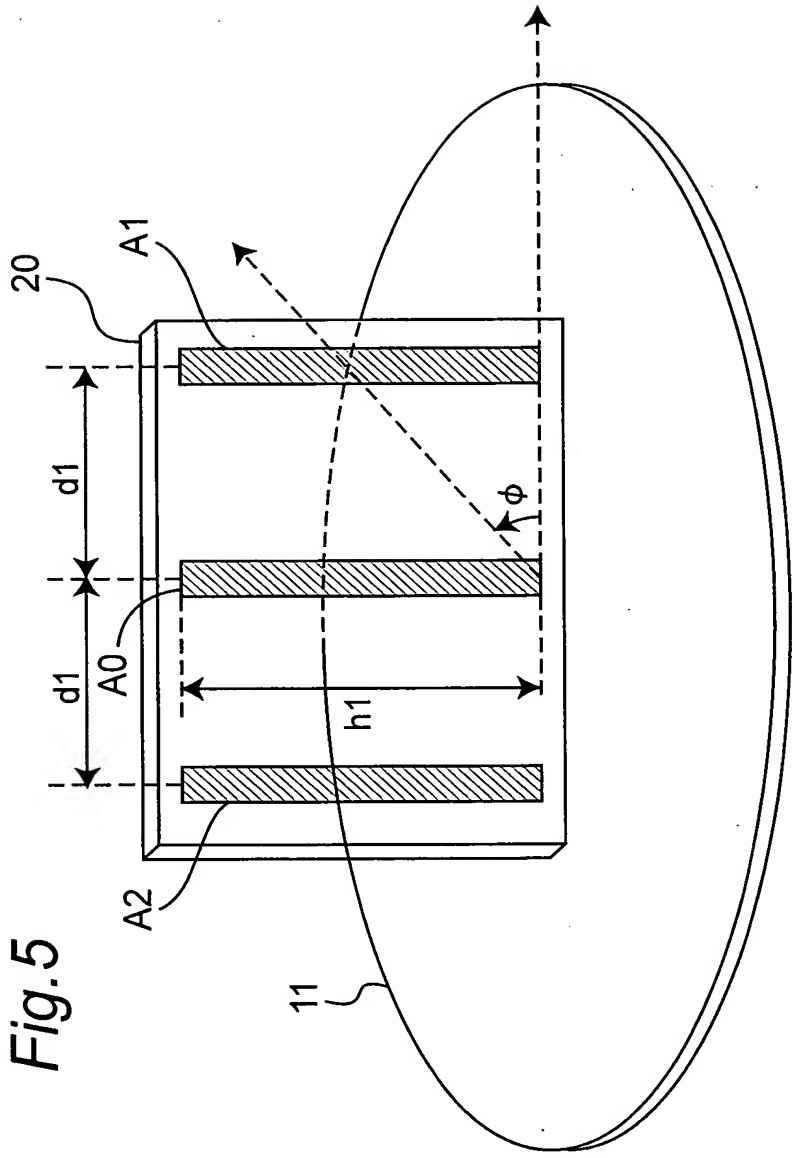


Fig.5

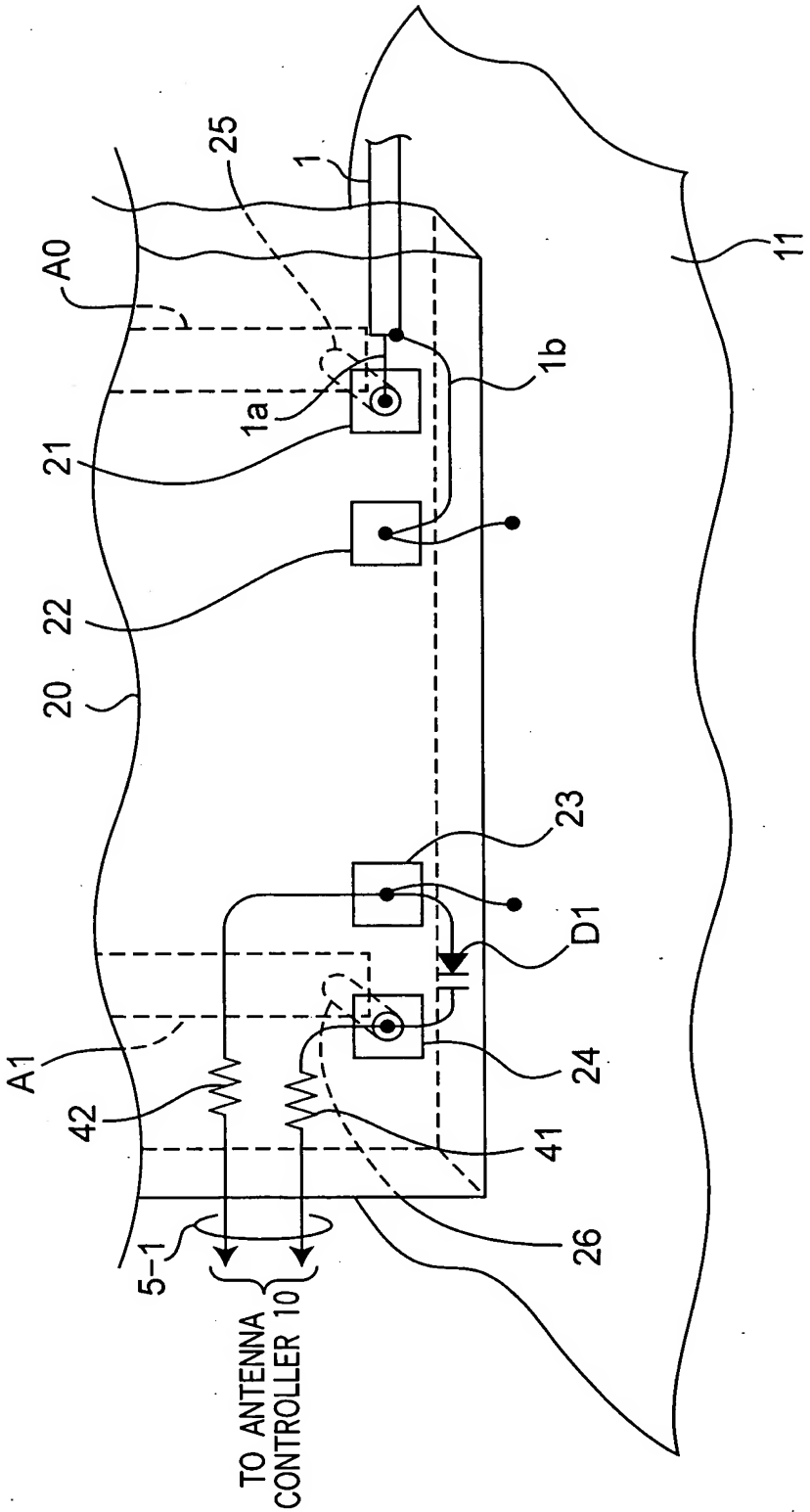

25
1
A0
11
1b
1a
21
22
20
23
D1
A1
24
42
41
26
5-1
TO ANTENNA CONTROLLER 10

Fig.6

Fig.7

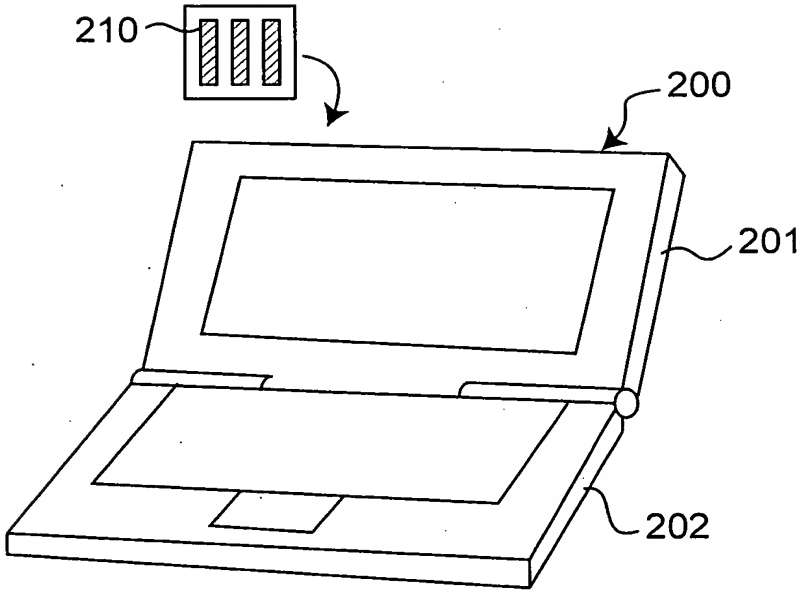


Fig.8

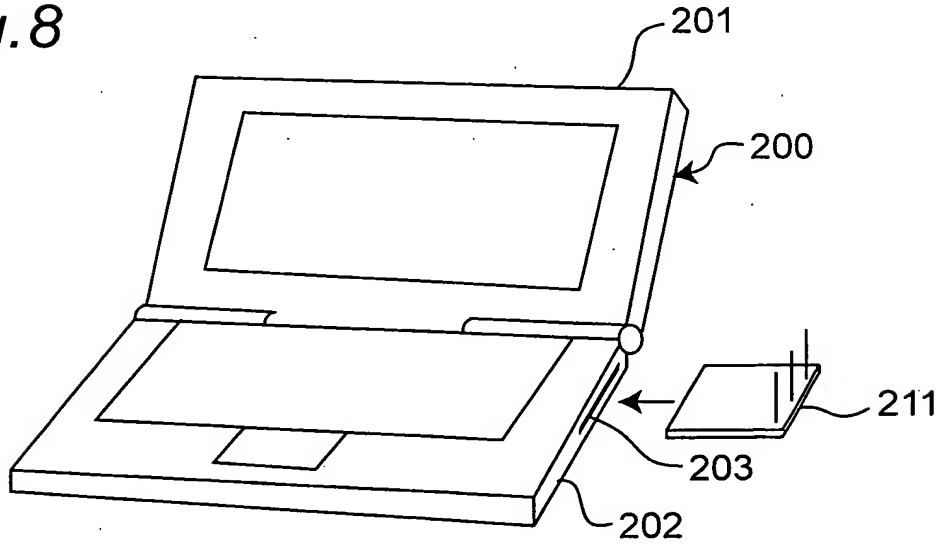
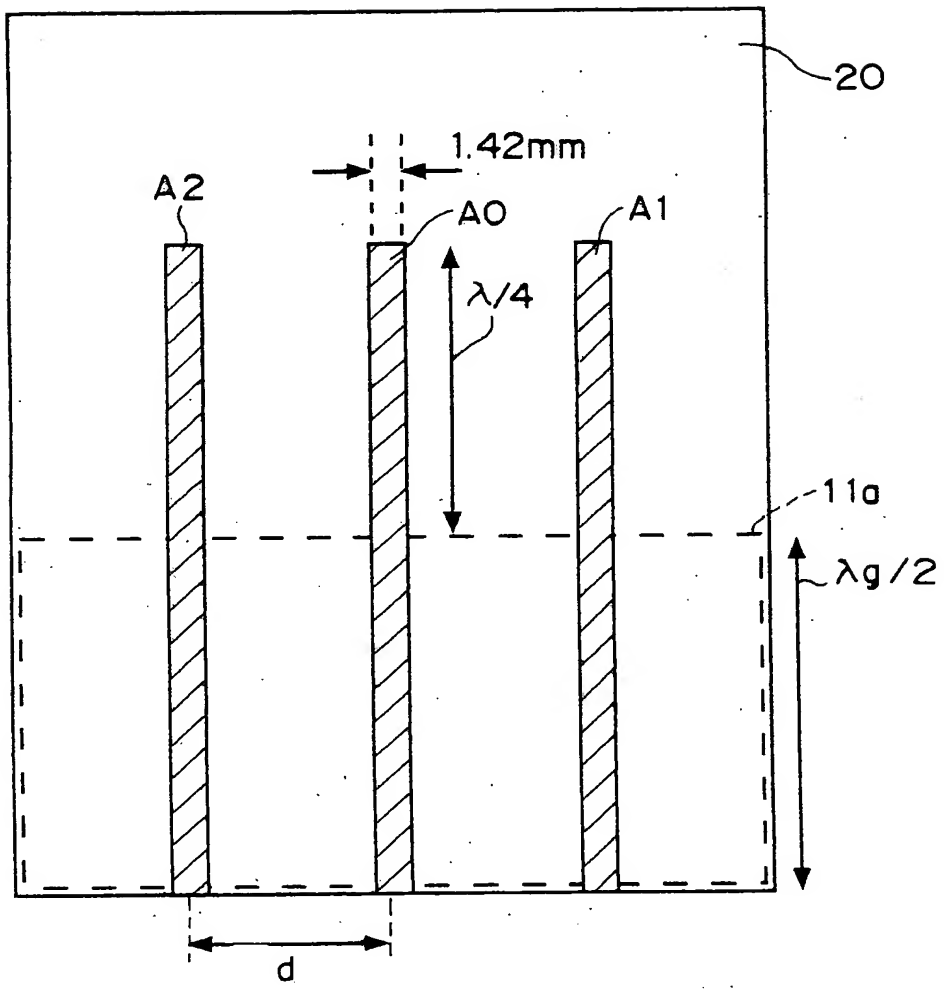


Fig.9



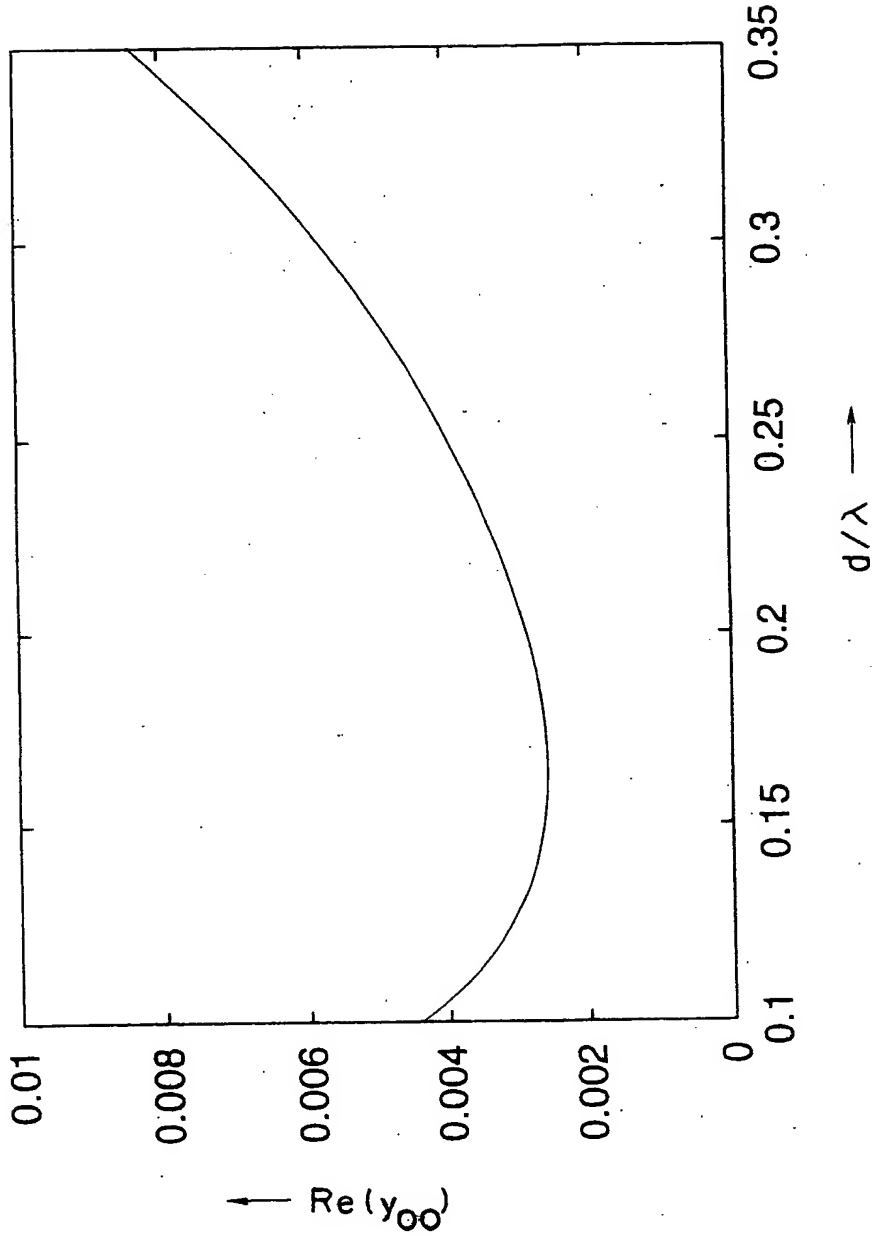


Fig.10

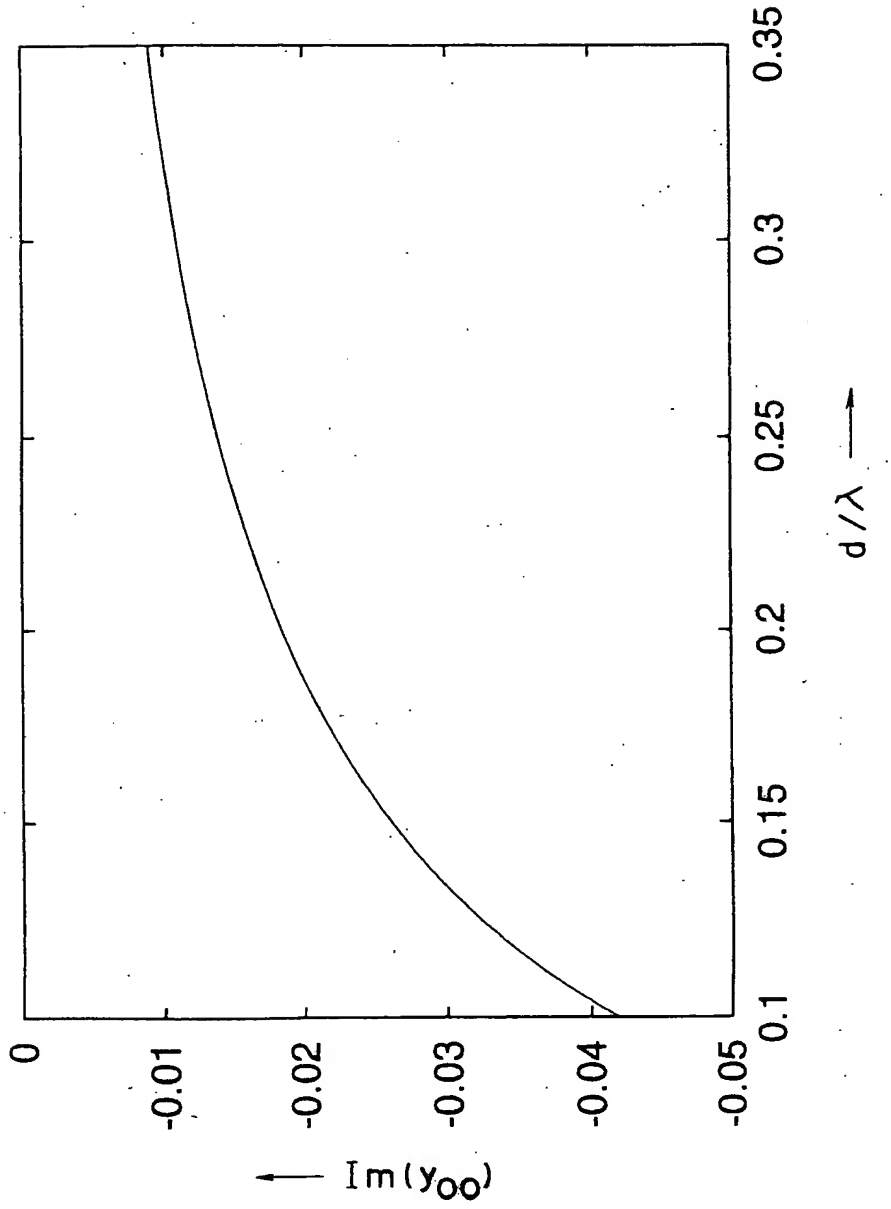


Fig.11

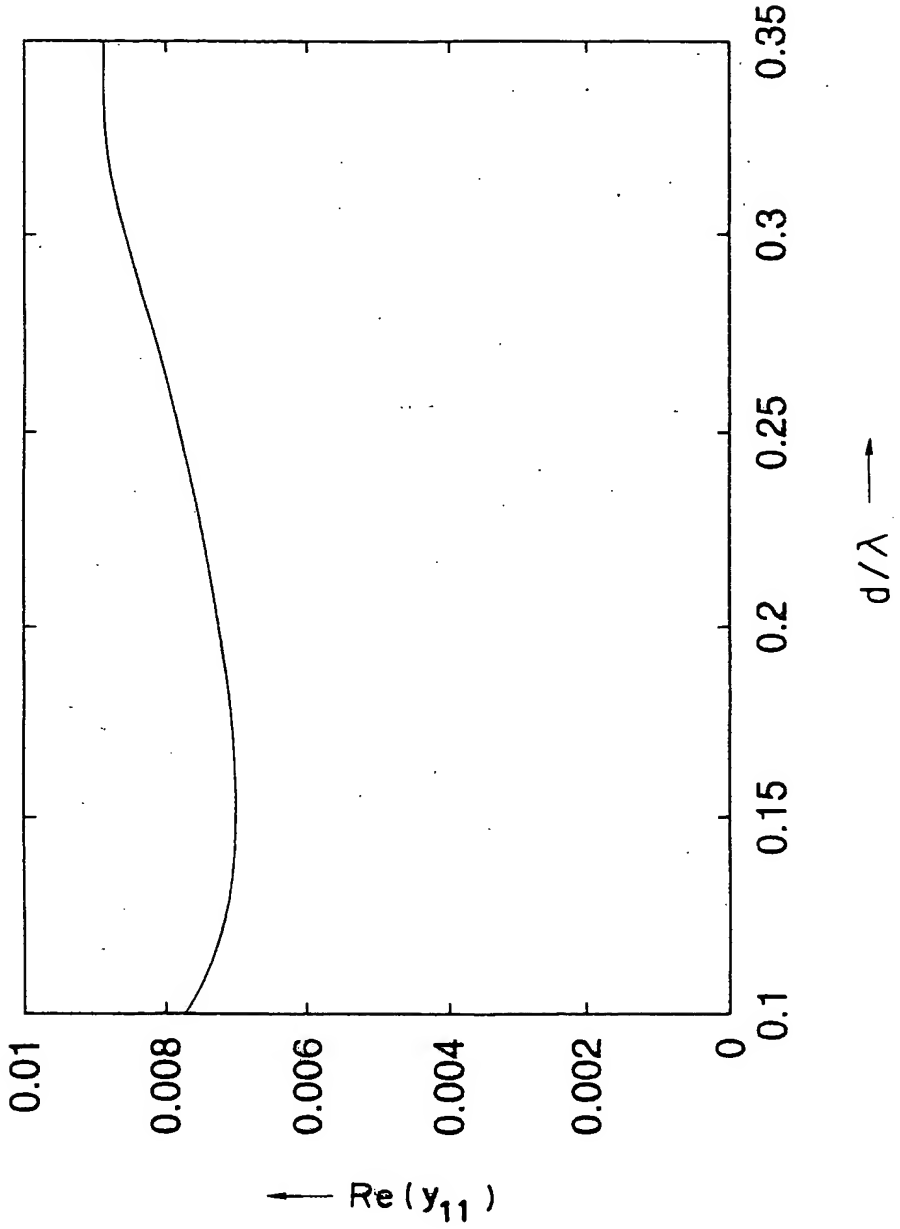


Fig. 12

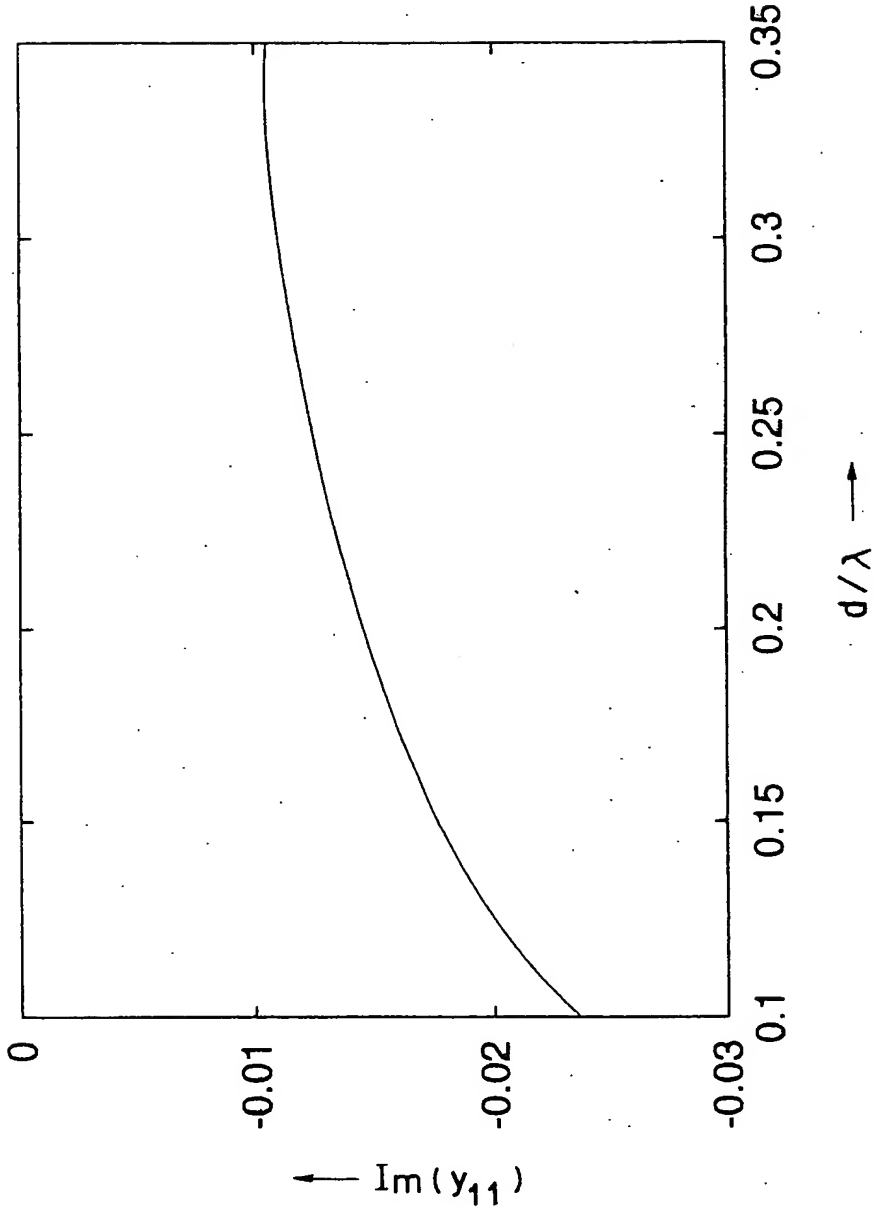


Fig. 13

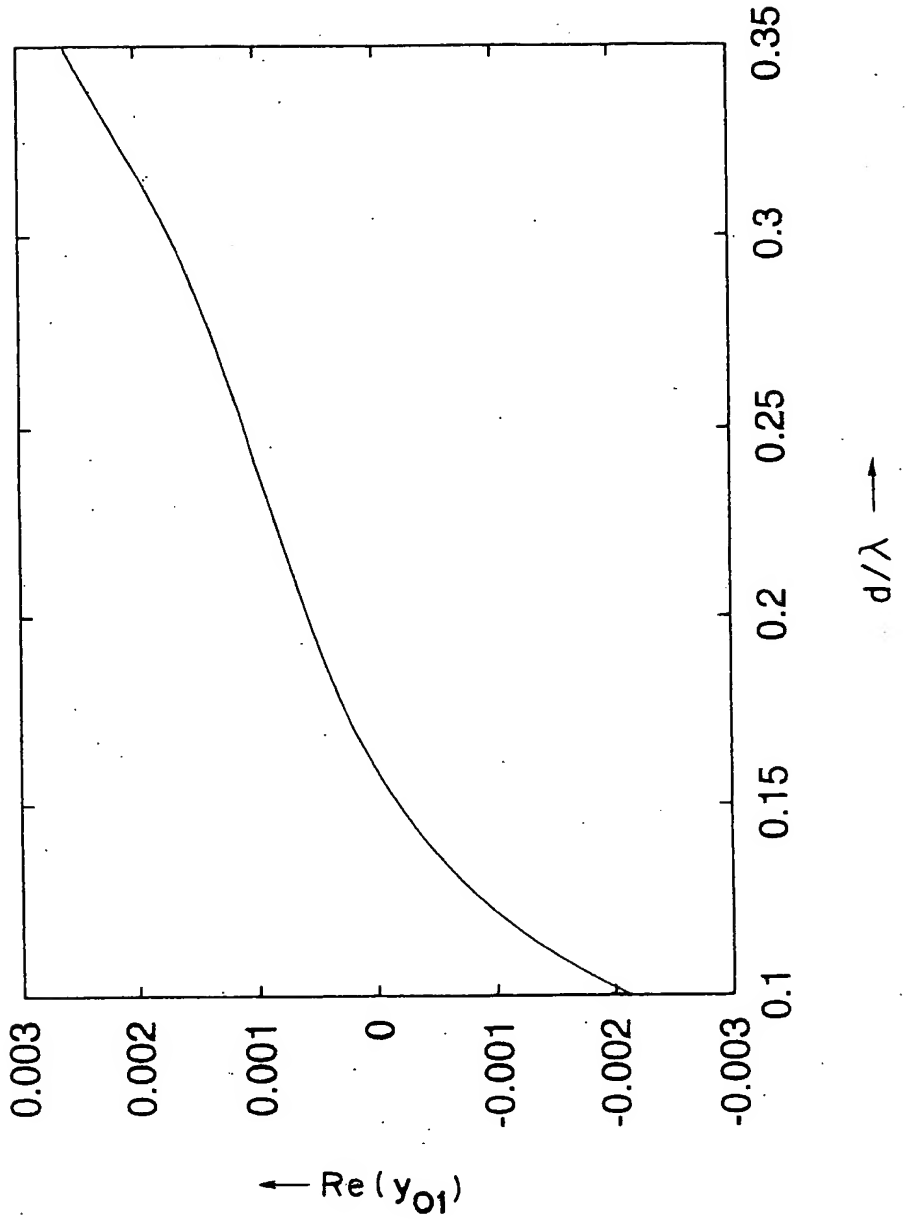


Fig. 14

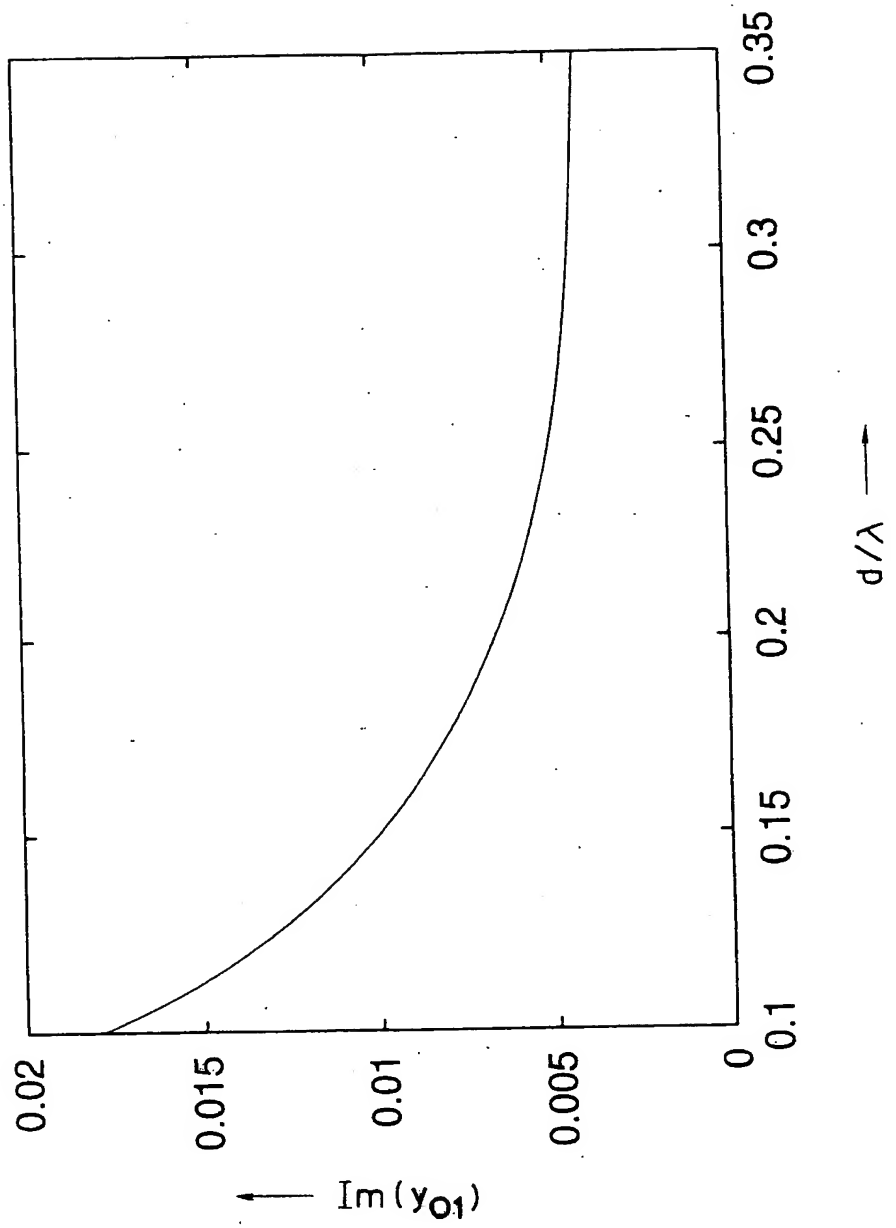


Fig.15

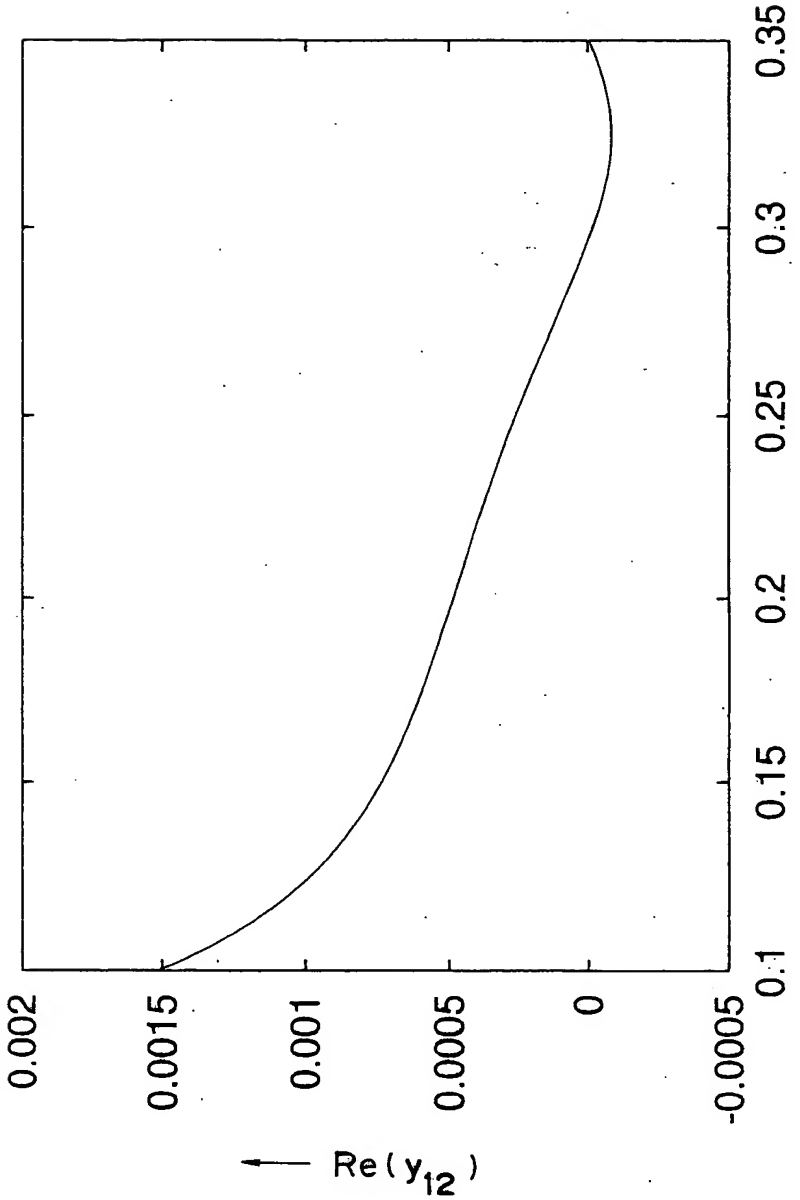


Fig.16

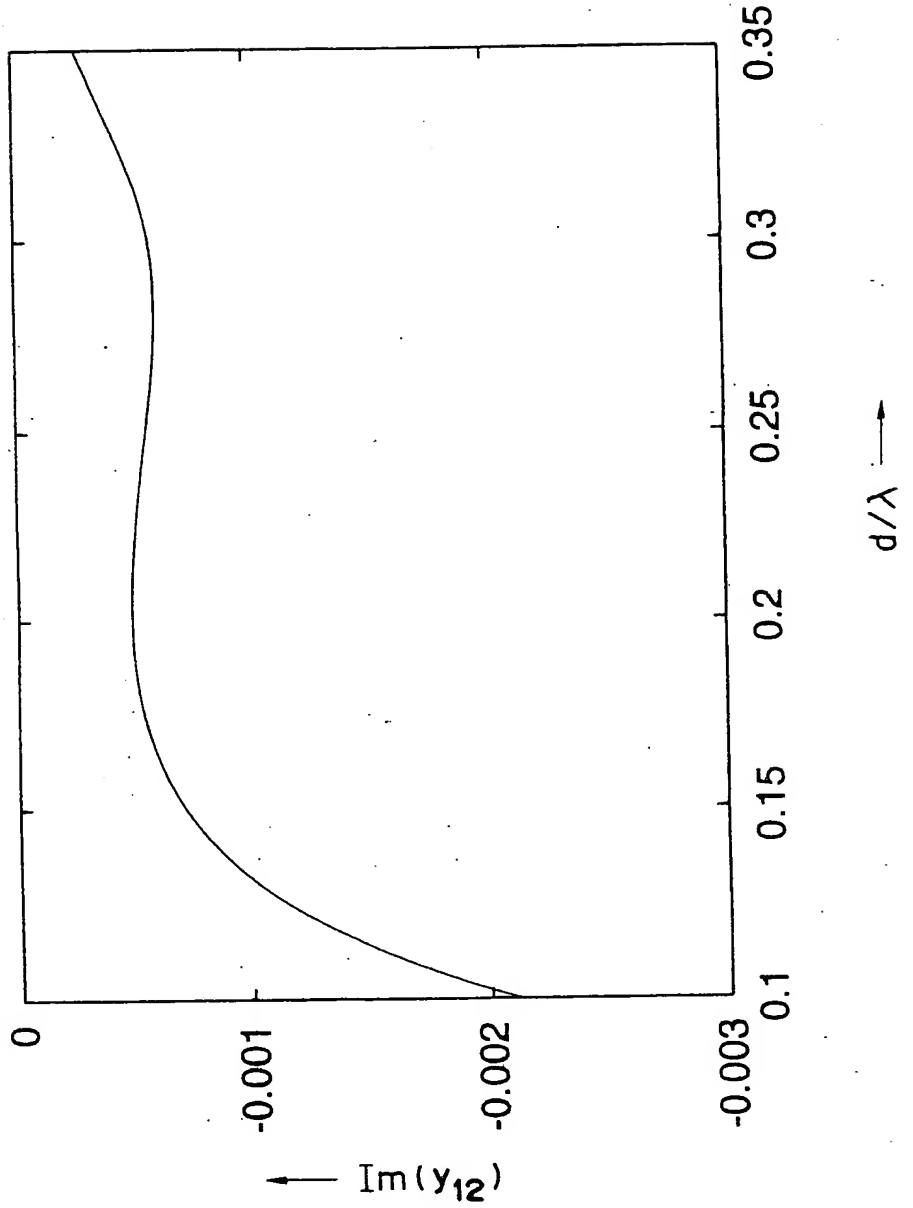
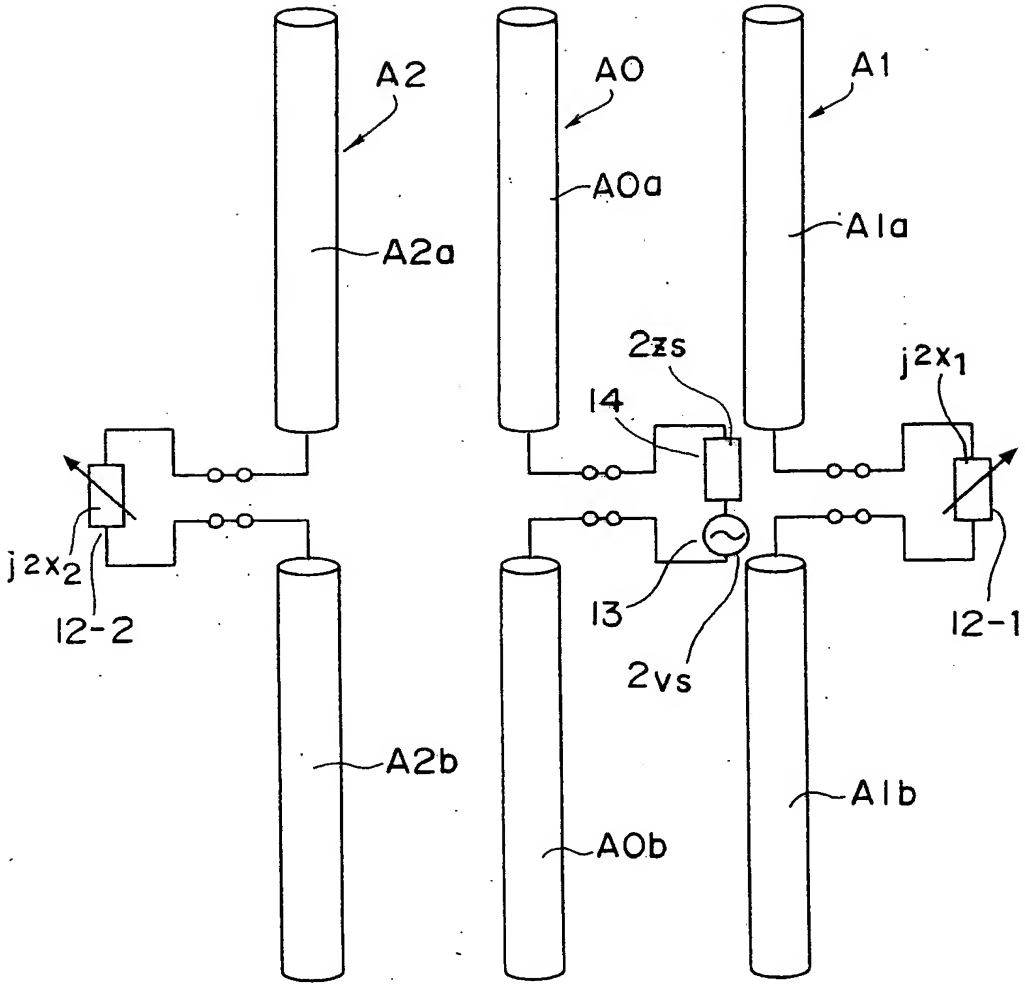


Fig.17

Fig.18



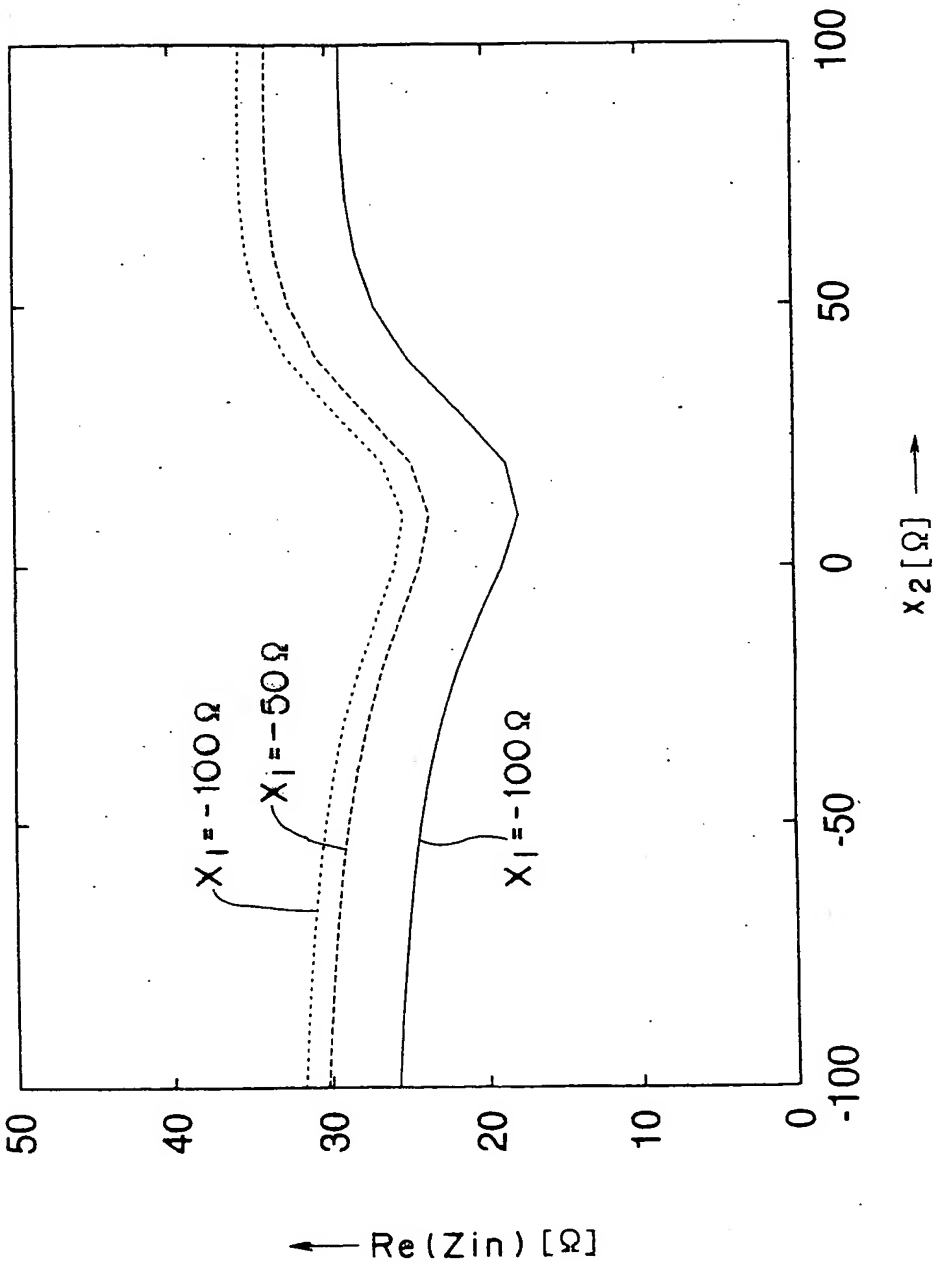


Fig. 19

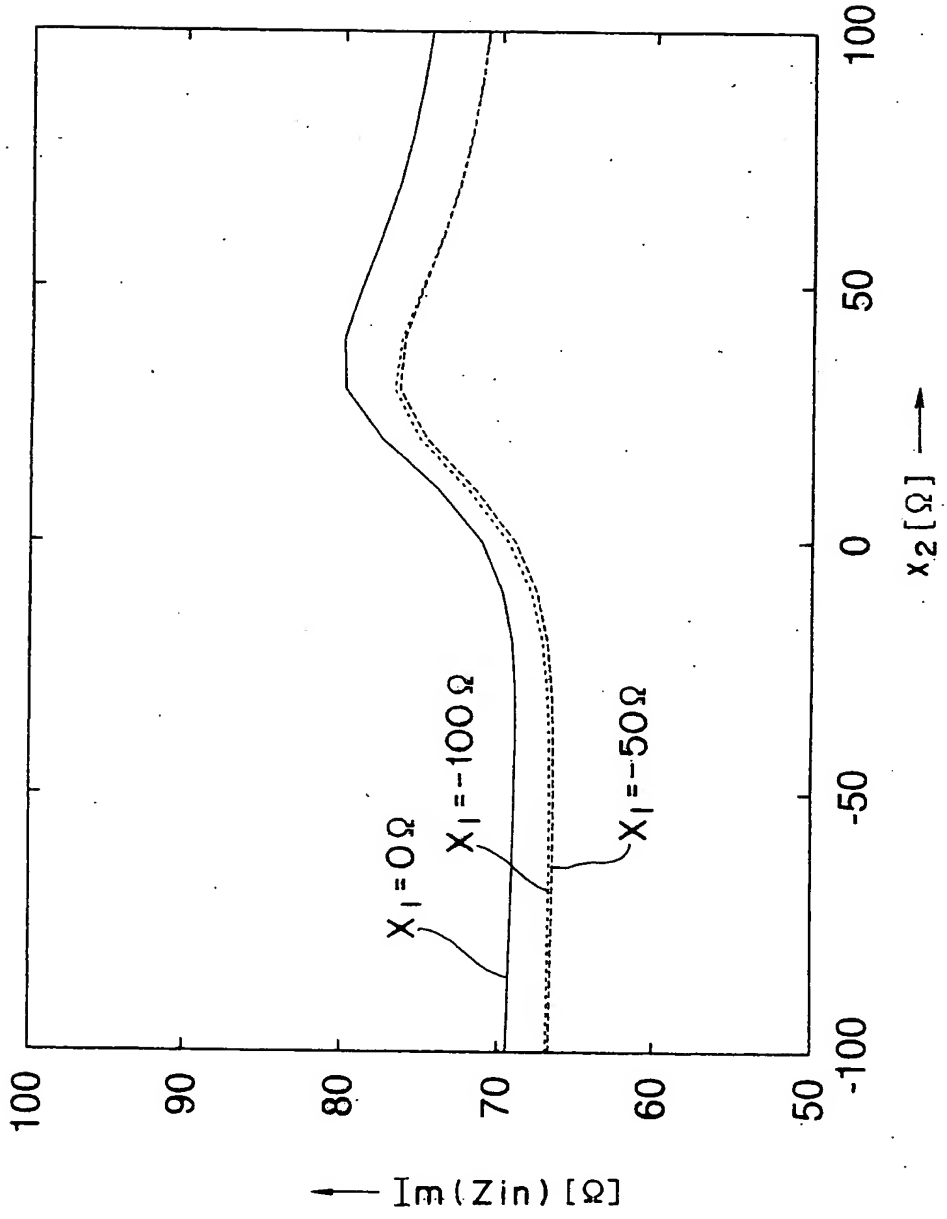


Fig.20

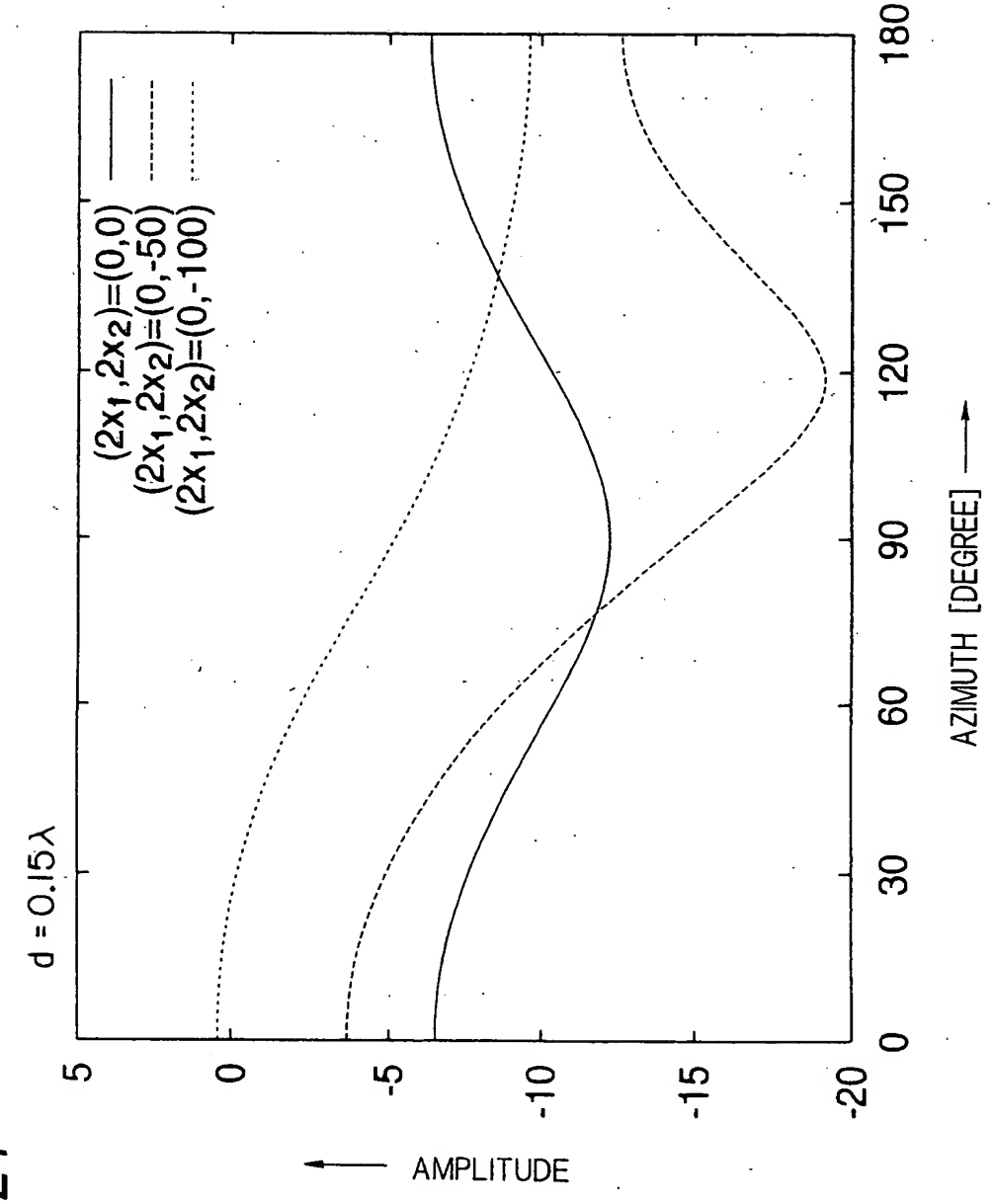

d = 0.15λ
(2x1,2x2)=(0,0)
(2x1,2x2)=(0,-50)
(2x1,2x2)=(0,-100)
5
0
-5
-10
-15
-20
AMPLITUDE
0
30
60
90
120
150
180
AZIMUTH [DEGREE]

Fig.21

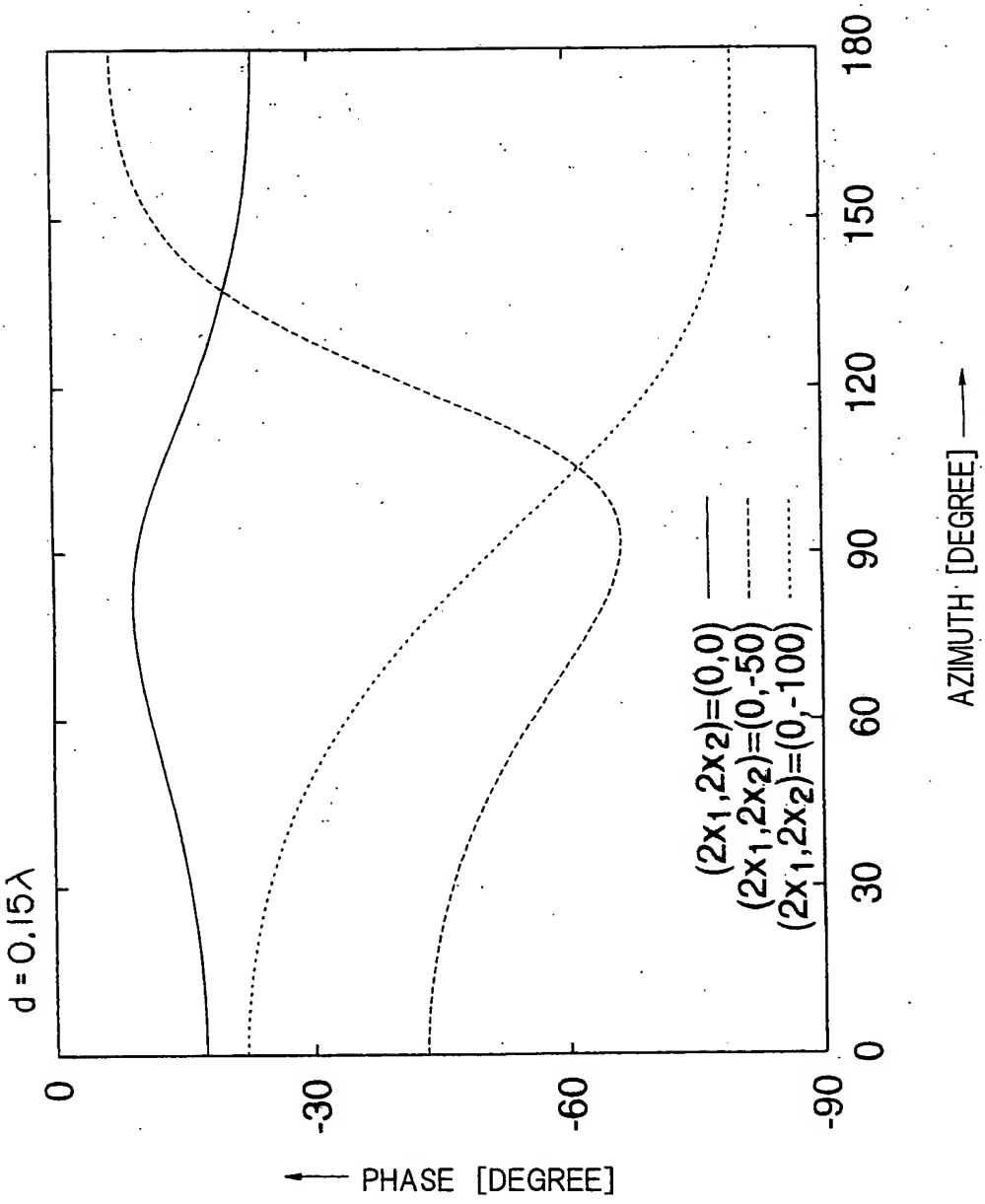

d = 0.15λ
0
-30
-60
-90
PHASE [DEGREE]
0
30
60
90
120
150
180
AZIMUTH [DEGREE]
(2x1,2x2)=(0,0)
(2x1,2x2)=(0,-50)
(2x1,2x2)=(0,-100)

Fig.22

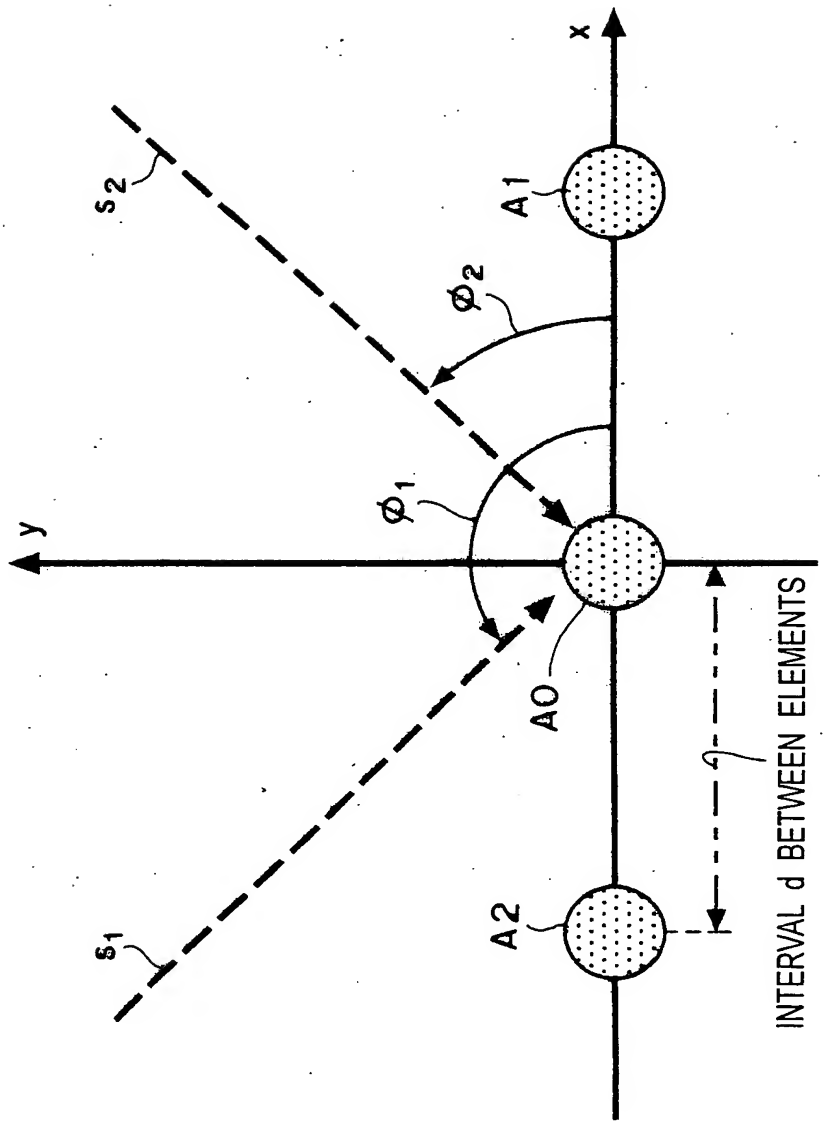


Fig.23

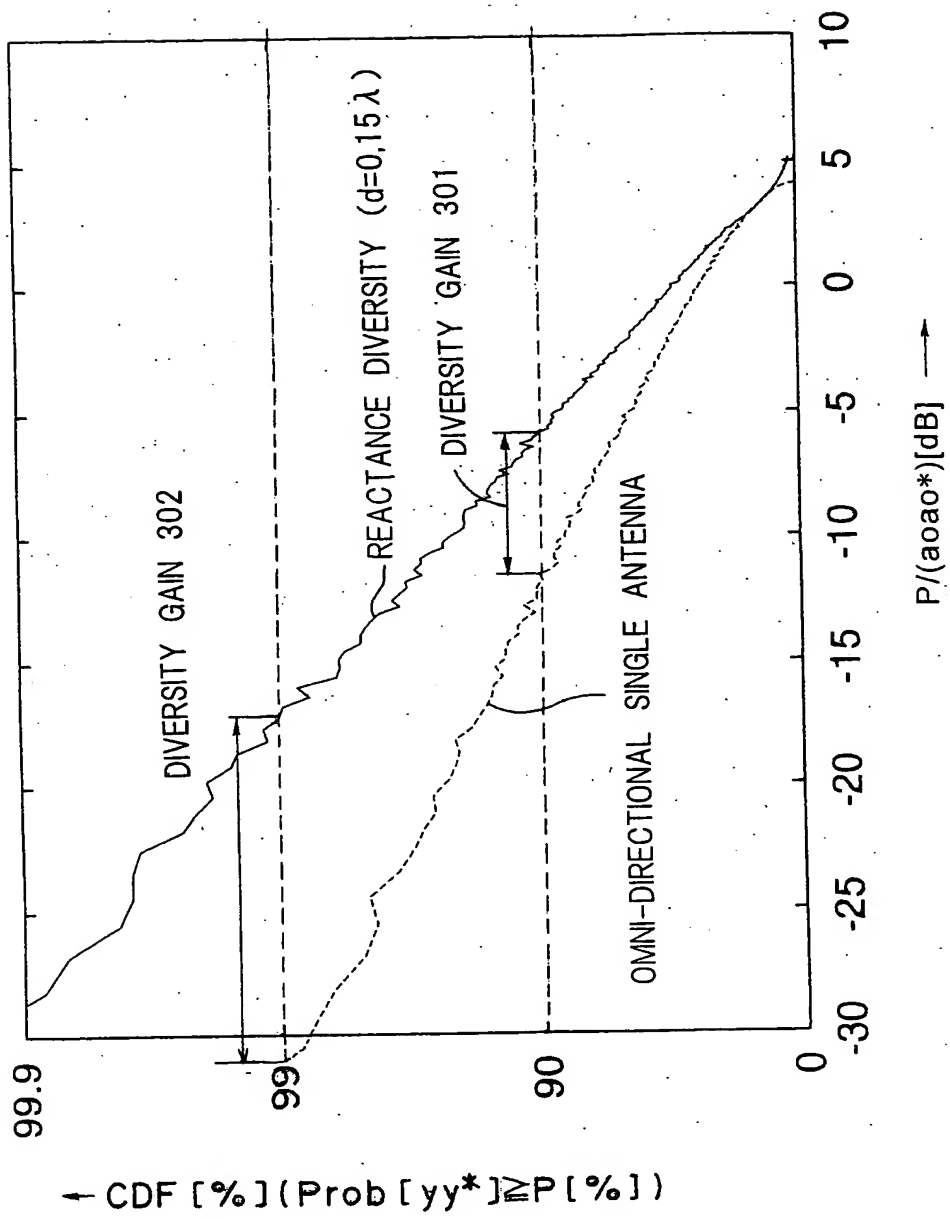

DIVERSITY GAIN 302
REACTANCE DIVERSITY (d=0,15λ)
DIVERSITY GAIN 301
OMNI-DIRECTIONAL SINGLE ANTENNA
99.9
99
90
0
10
5
0
-5
-10
-15
-20
-25
-30
← CDF [%] (Prob [yy*] ≧ P [%])
P/(aoao*)[dB] →

Fig.24

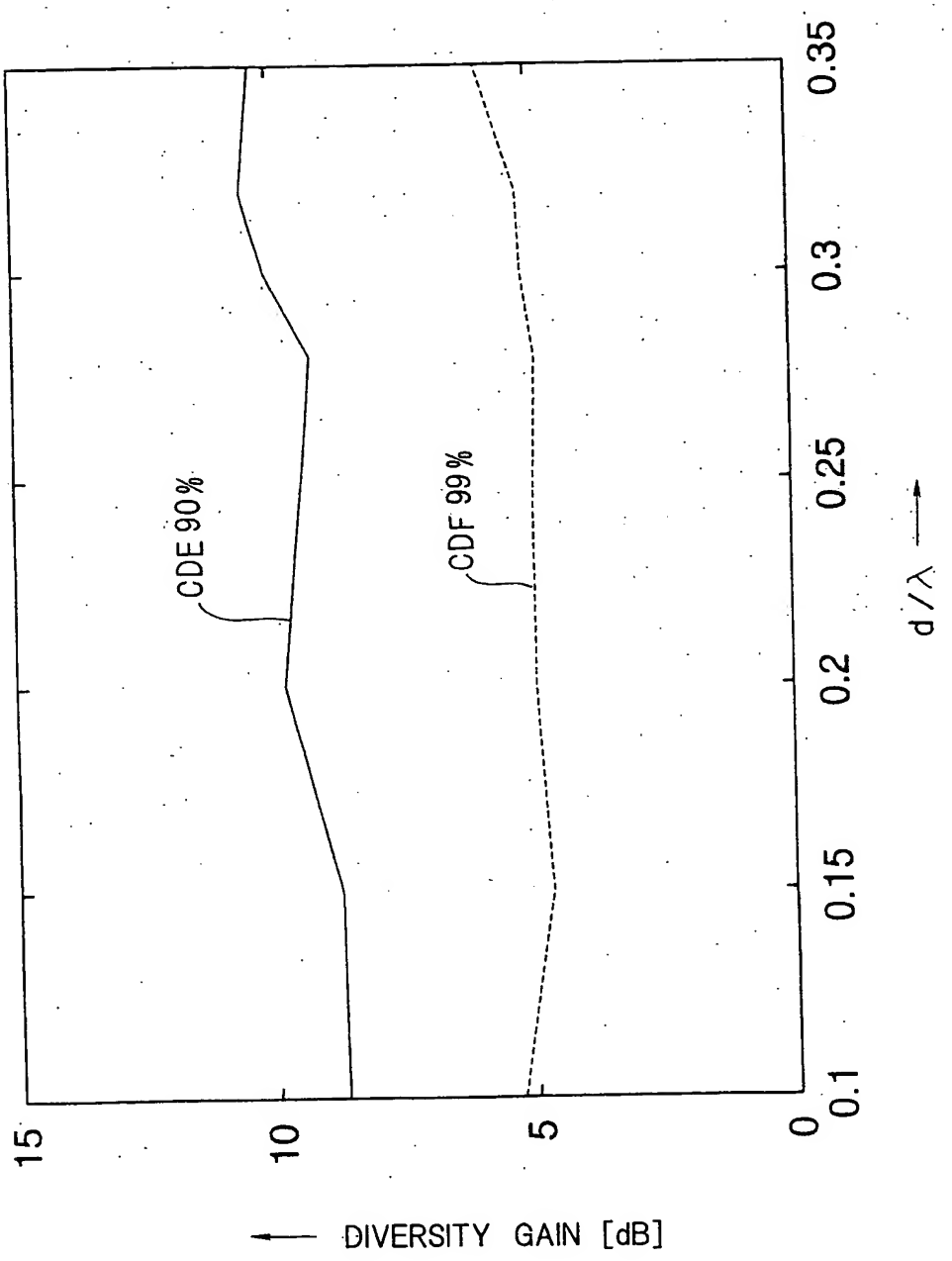


Fig.25

Fig.26

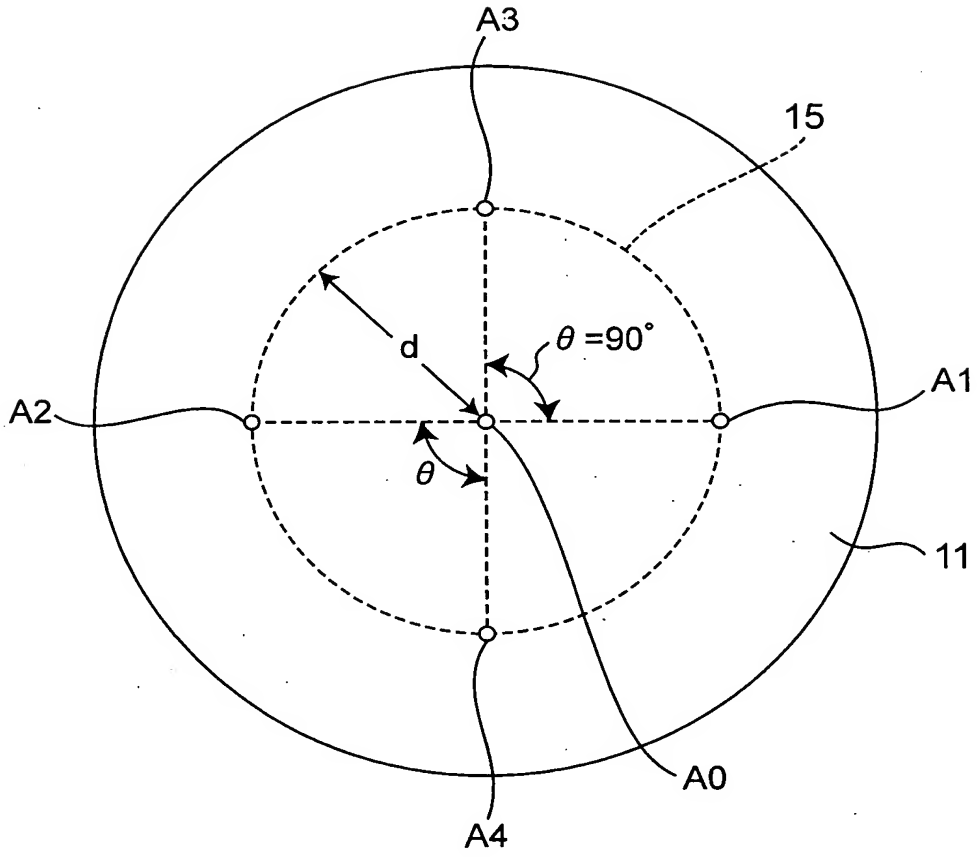


Fig.27

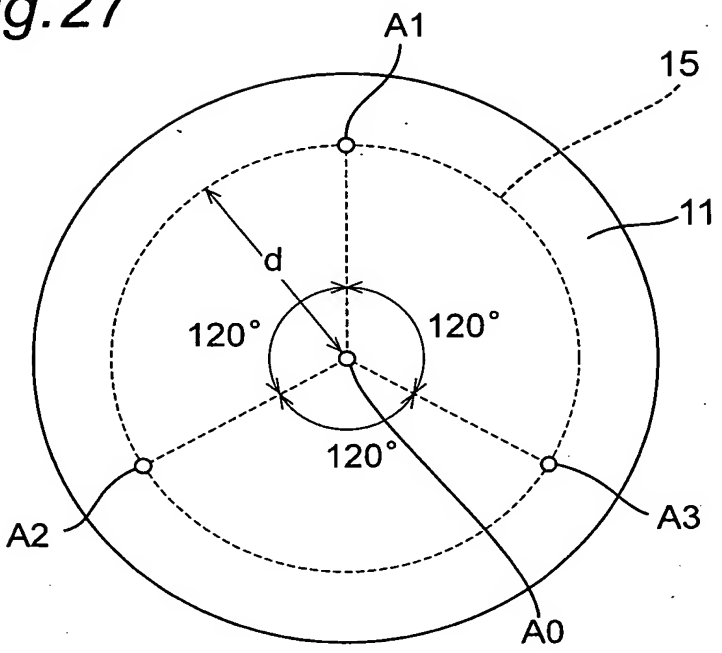


Fig.28

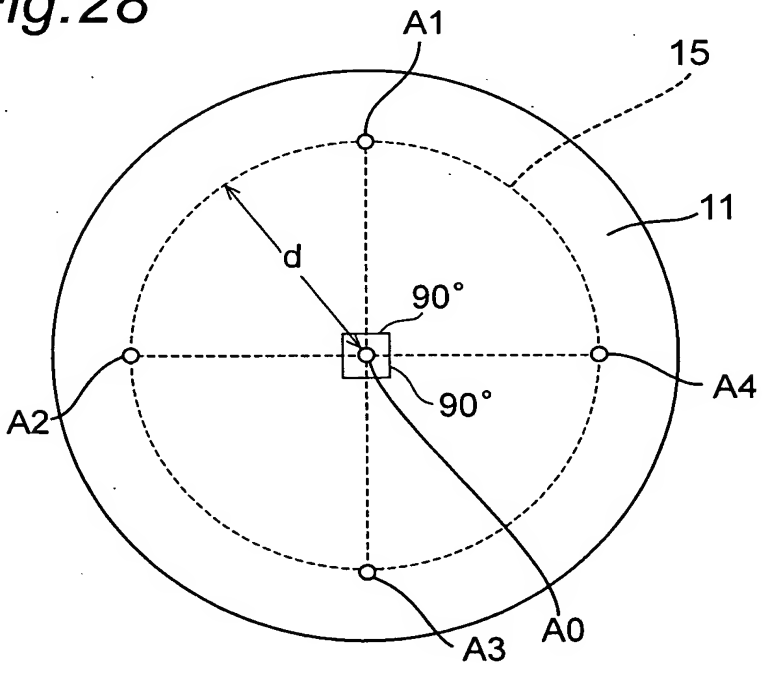


Fig.29

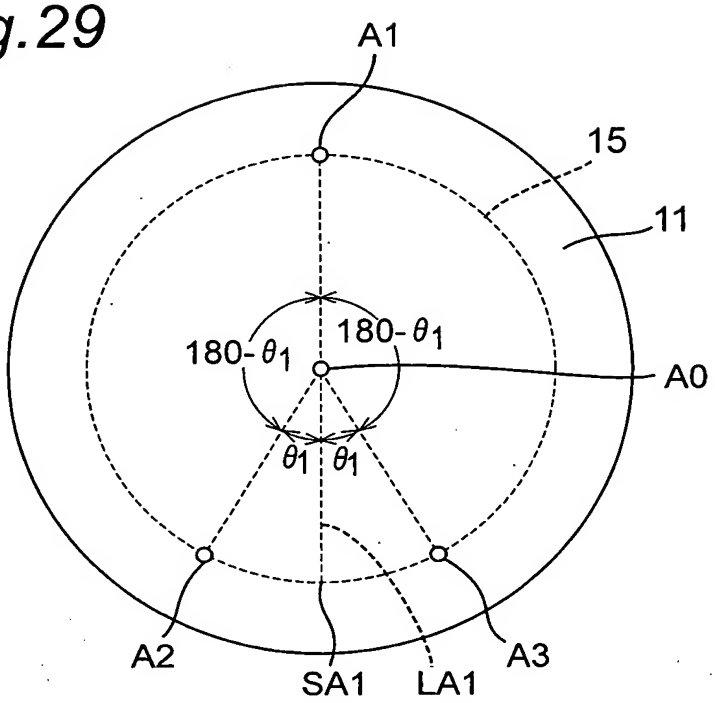

A1
15
11
180-θ1
180-θ1
A0
θ1
θ1
A2
SA1
LA1
A3

Fig.30

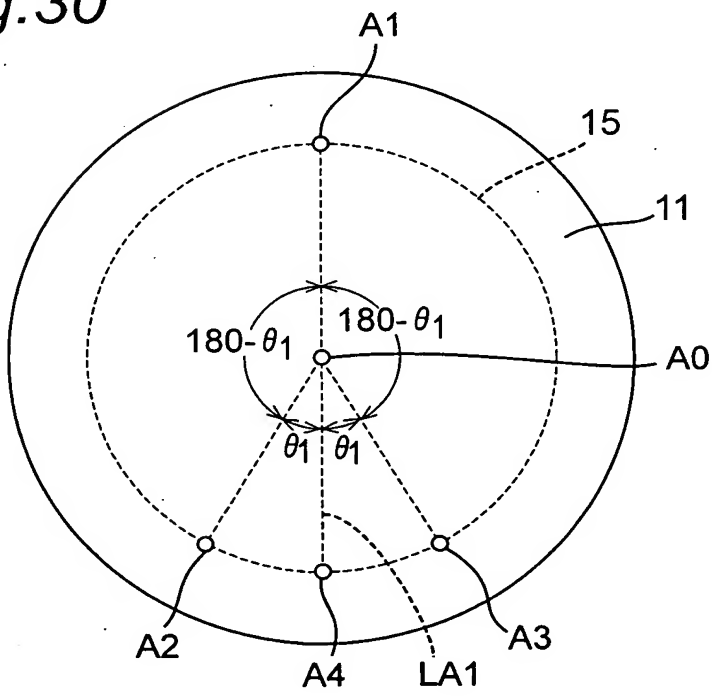

A1
15
11
180-θ1
180-θ1
A0
θ1
θ1
A2
A4
LA1
A3

Fig.31

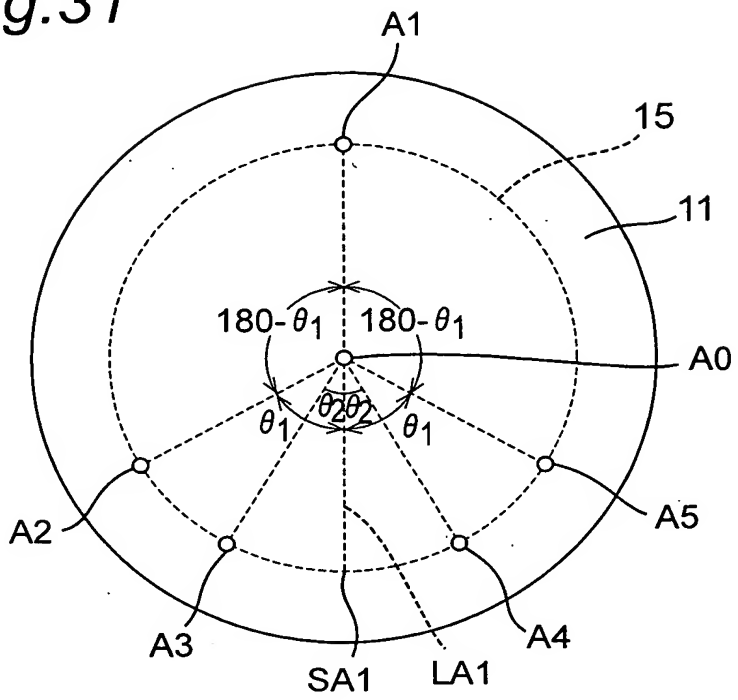

A1
15
11
180-θ1
180-θ1
A0
θ2
θ1
θ1
A2
A5
A3
A4
SA1
LA1

Fig.32

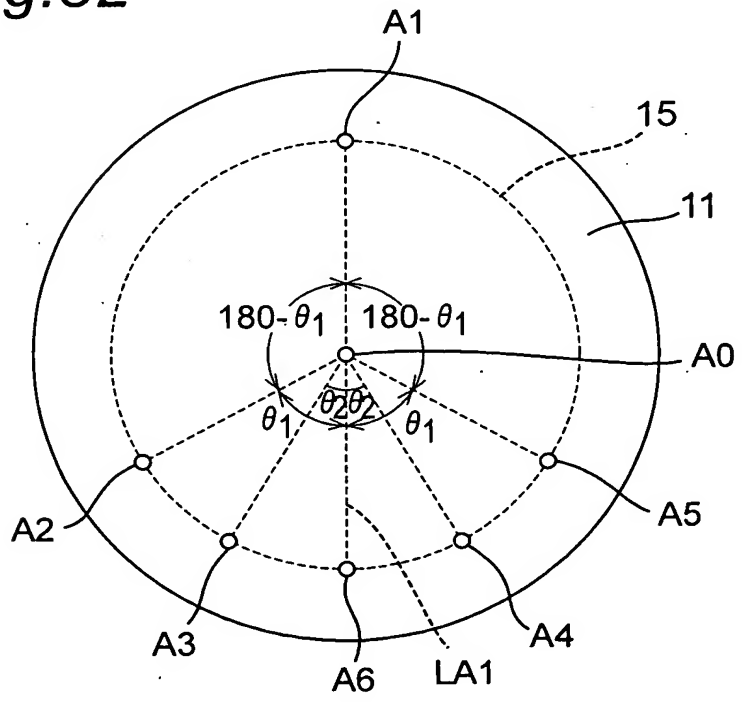
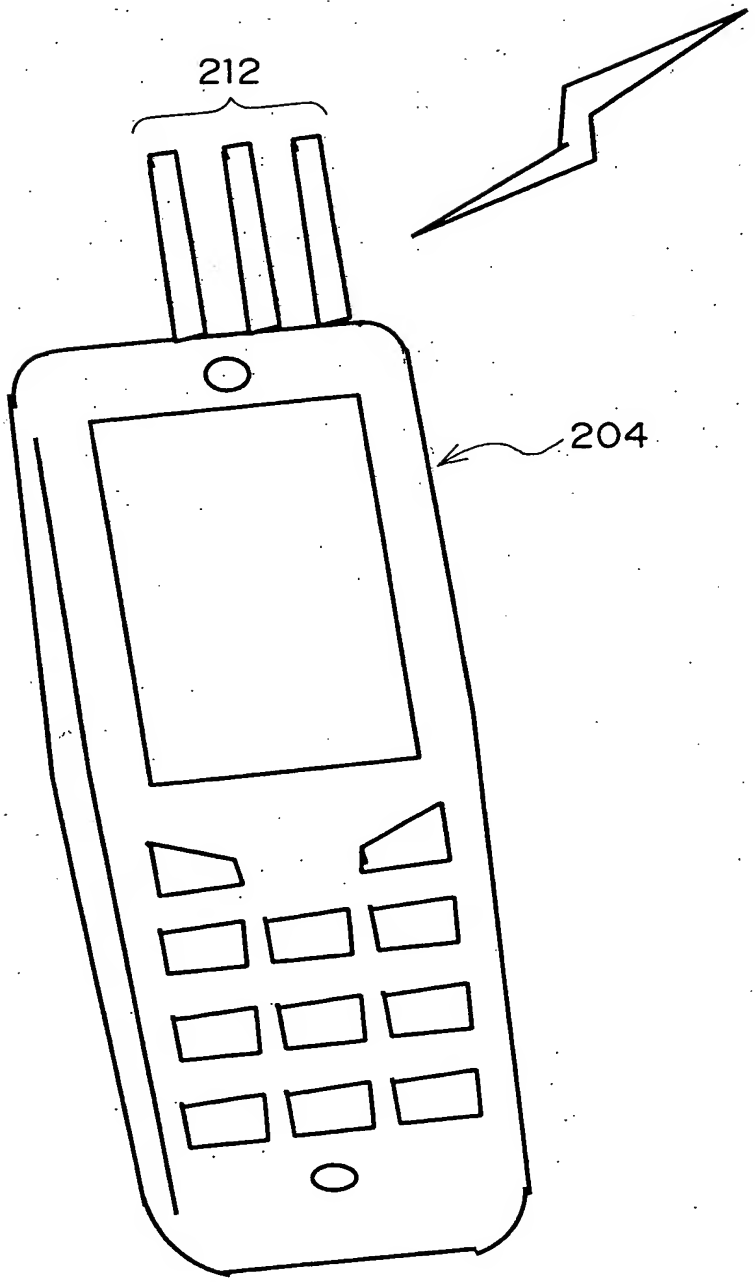

A1
15
11
180-θ1
180-θ1
A0
θ2
θ1
θ1
A2
A5
A3
A4
A6
LA1

Fig.33



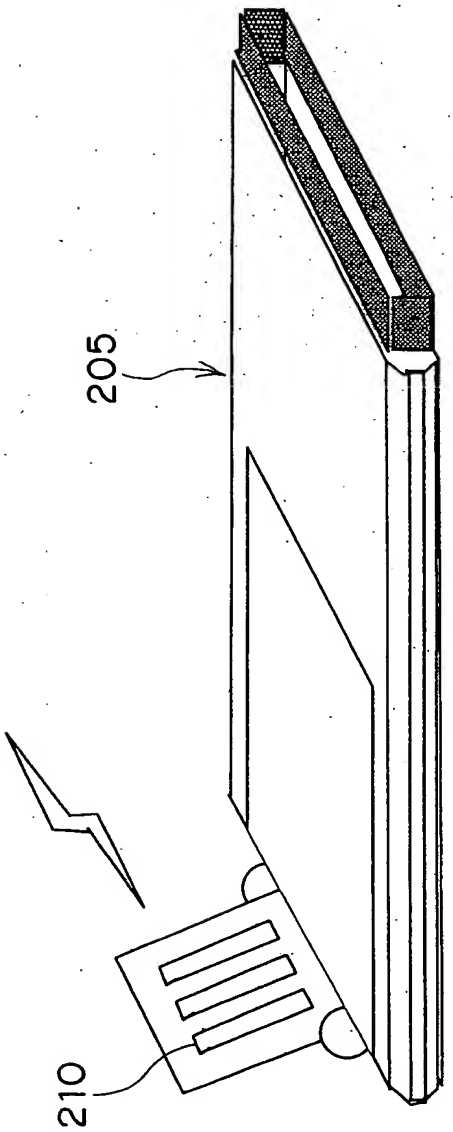
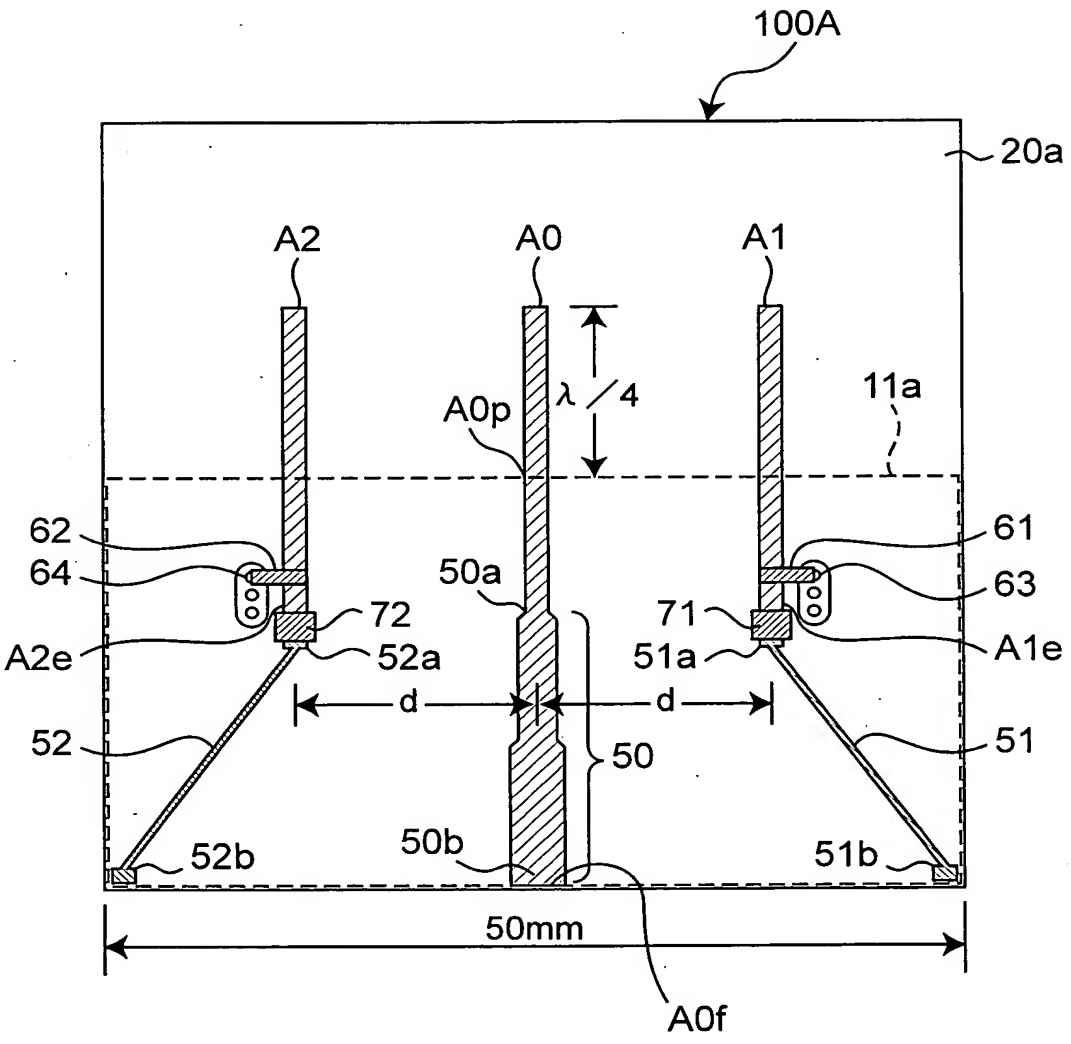


Fig.34

Fig.35


100A
20a
A2
A0
A1
λ/4
A0p
11a
62
64
61
63
50a
72
71
A2e
52a
51a
A1e
d
d
52
50
51
52b
50b
51b
50mm
A0f

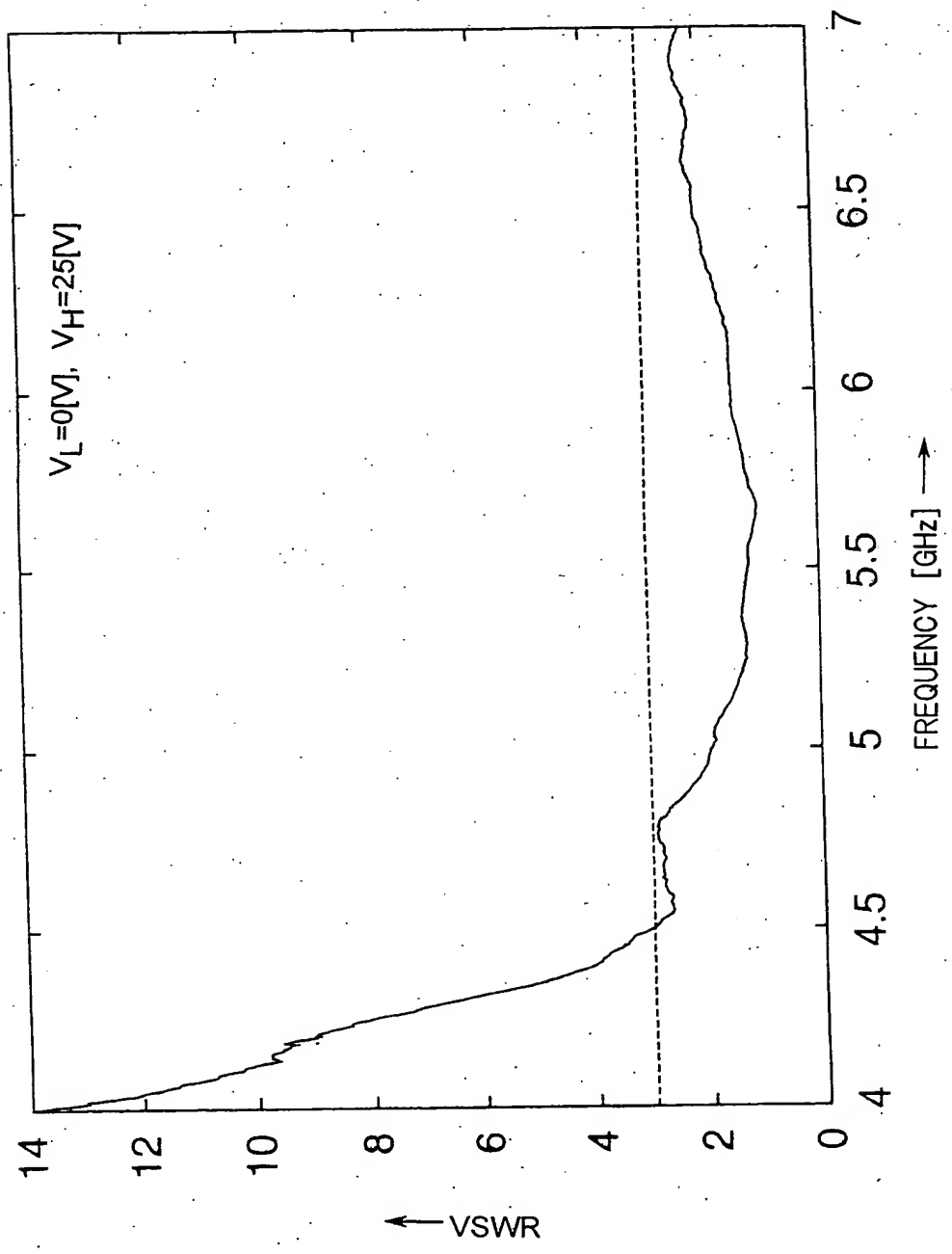
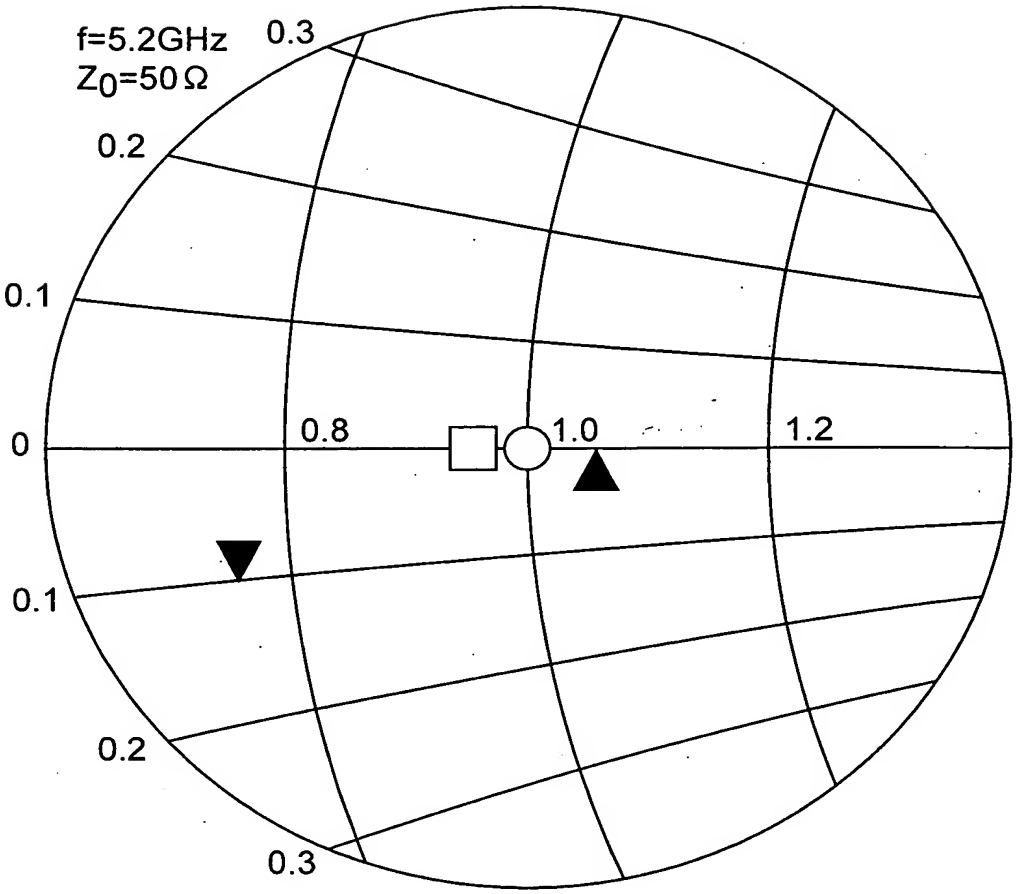


Fig.36

Fig.37


f=5.2GHz
Z_0=50Ω
0.3
0.2
0.1
0
0.8
1.0
1.2
0.1
0.2
0.3
THREE-ELEMENT ANTENNA APPARATUS, (V1,V2)=(0,25)[V]
THREE-ELEMENT ANTENNA APPARATUS, (V1,V2)=(25,0)[V]
TWO-ELEMENT ANTENNA APPARATUS, V=25[V]
TWO-ELEMENT ANTENNA APPARATUS, V=0[V]

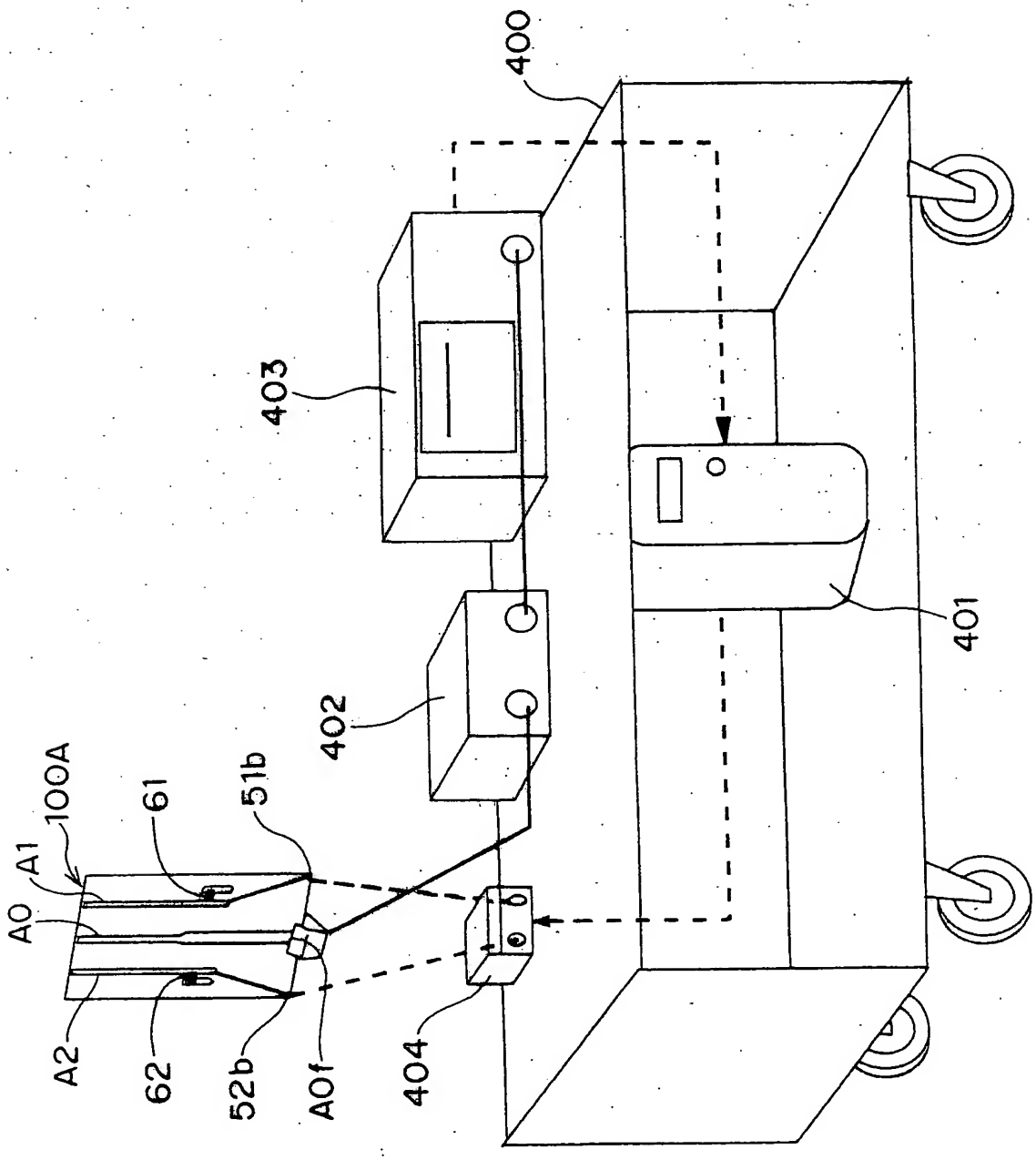


Fig.38

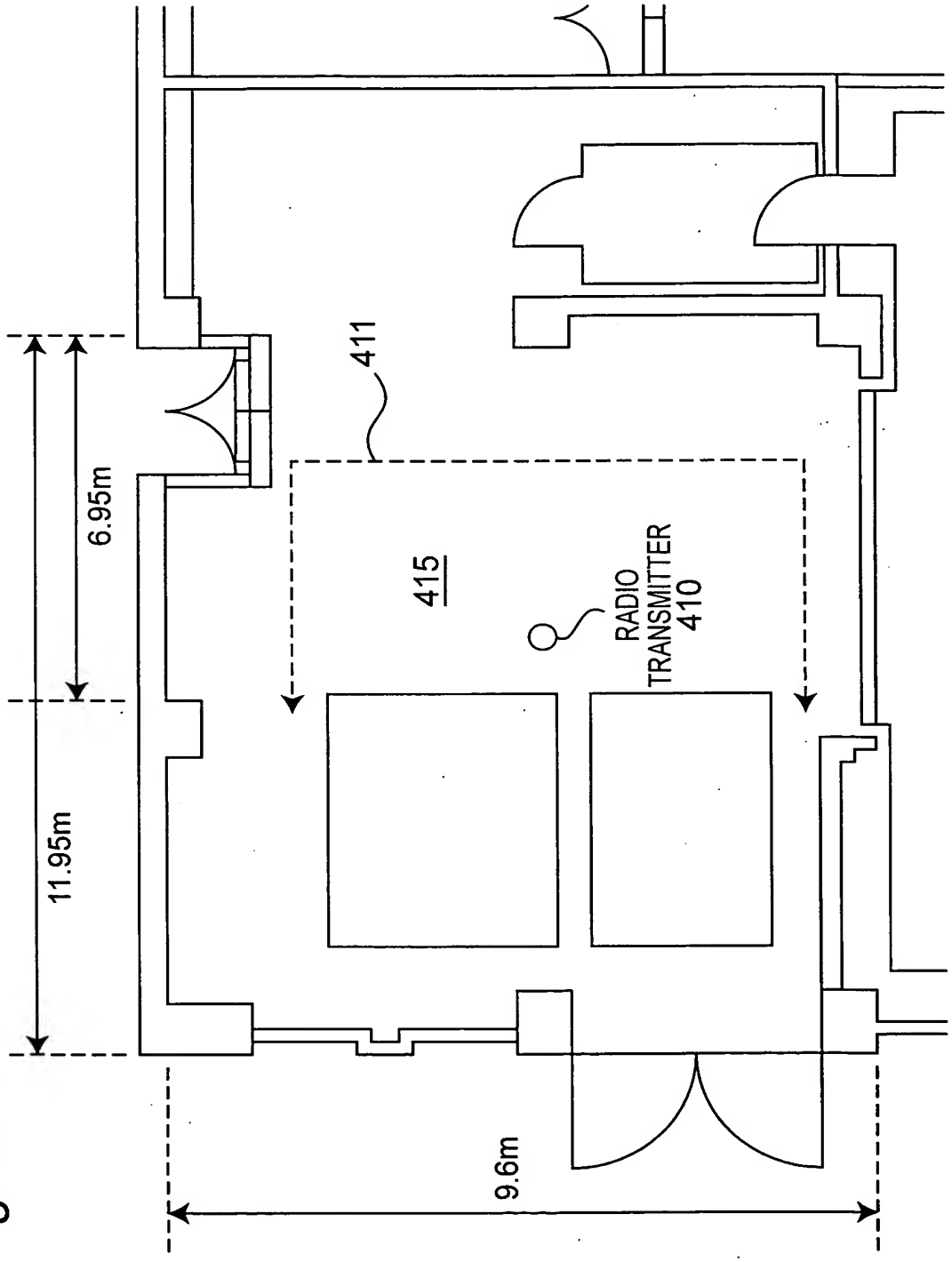


Fig.39

Fig.40

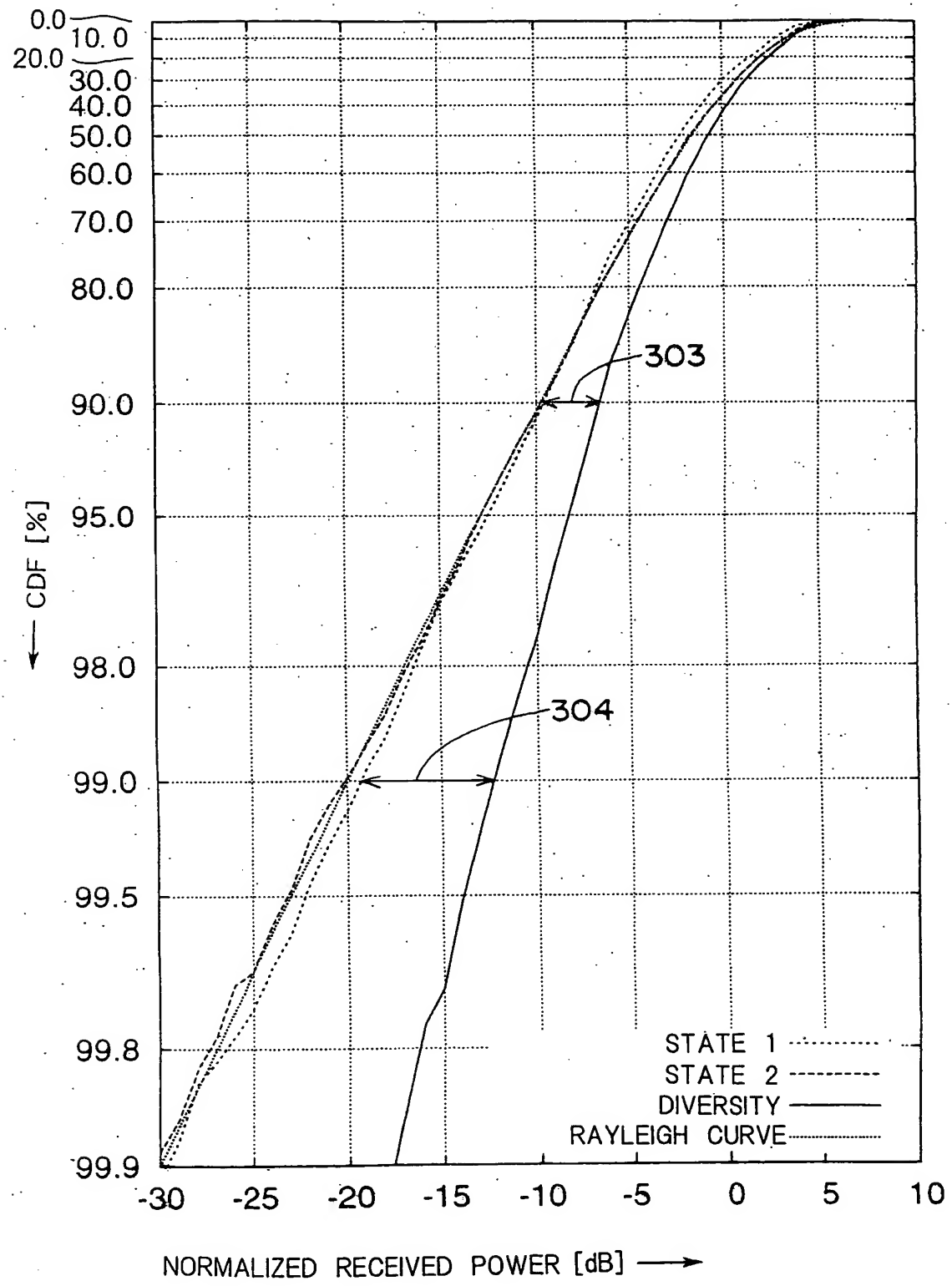
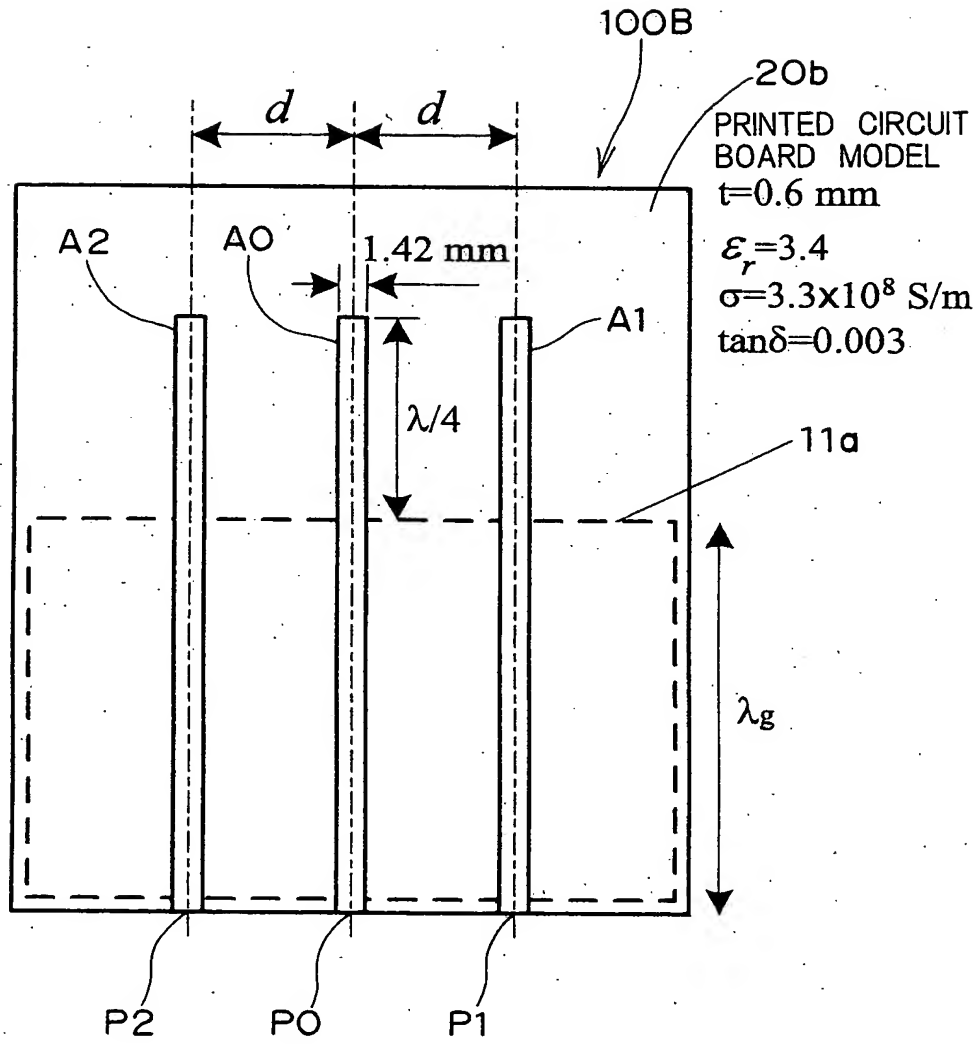

0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
95.0
98.0
99.0
99.5
99.8
99.9
CDF [%]
303
304
STATE 1
STATE 2
DIVERSITY
RAYLEIGH CURVE
-30
-25
-20
-15
-10
-5
0
5
10
NORMALIZED RECEIVED POWER [dB]

Fig.41


100B
20b
PRINTED CIRCUIT BOARD MODEL
t=0.6 mm
ε_r=3.4
σ=3.3x10^8 S/m
tanδ=0.003
d
d
A2
A0
1.42 mm
A1
λ/4
11a
λg
P2
P0
P1

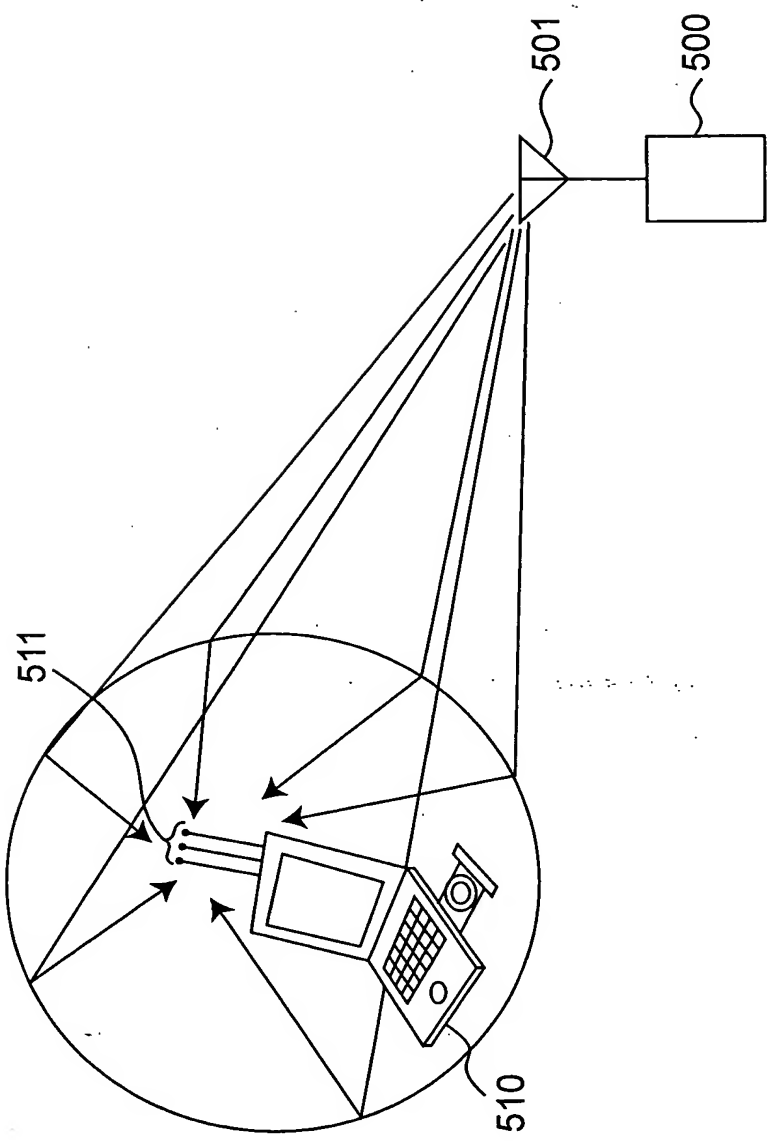


Fig.42

Fig.43

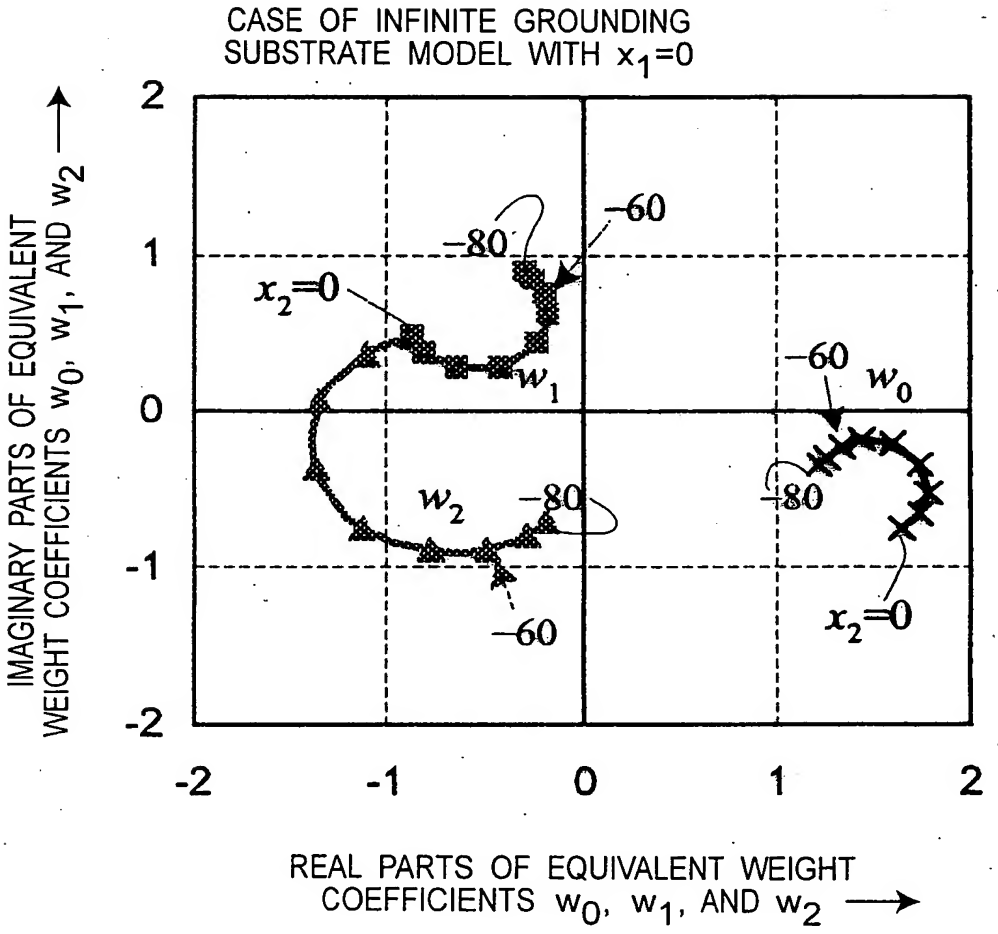

CASE OF INFINITE GROUNDING SUBSTRATE MODEL WITH x_1=0
IMAGINARY PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
REAL PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
2
1
0
-1
-2
-2
-1
0
1
2
-80
-60
x_2=0
w_1
w_2
-80
-60
-60
w_0
-80
x_2=0

Fig.44

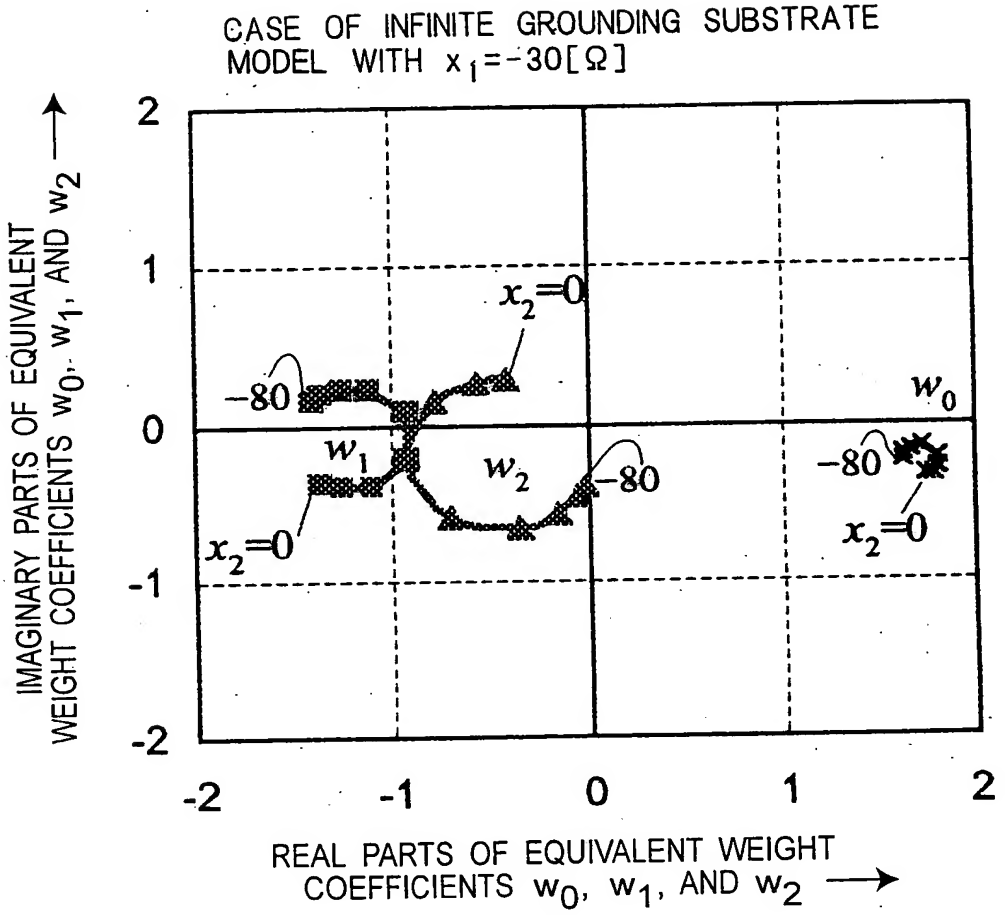

CASE OF INFINITE GROUNDING SUBSTRATE
MODEL WITH x_1=-30[Ω]
IMAGINARY PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
REAL PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
2
1
0
-1
-2
-2
-1
0
1
2
x_2=0
-80
w_0
w_1
w_2
-80
-80
x_2=0
x_2=0

Fig.45

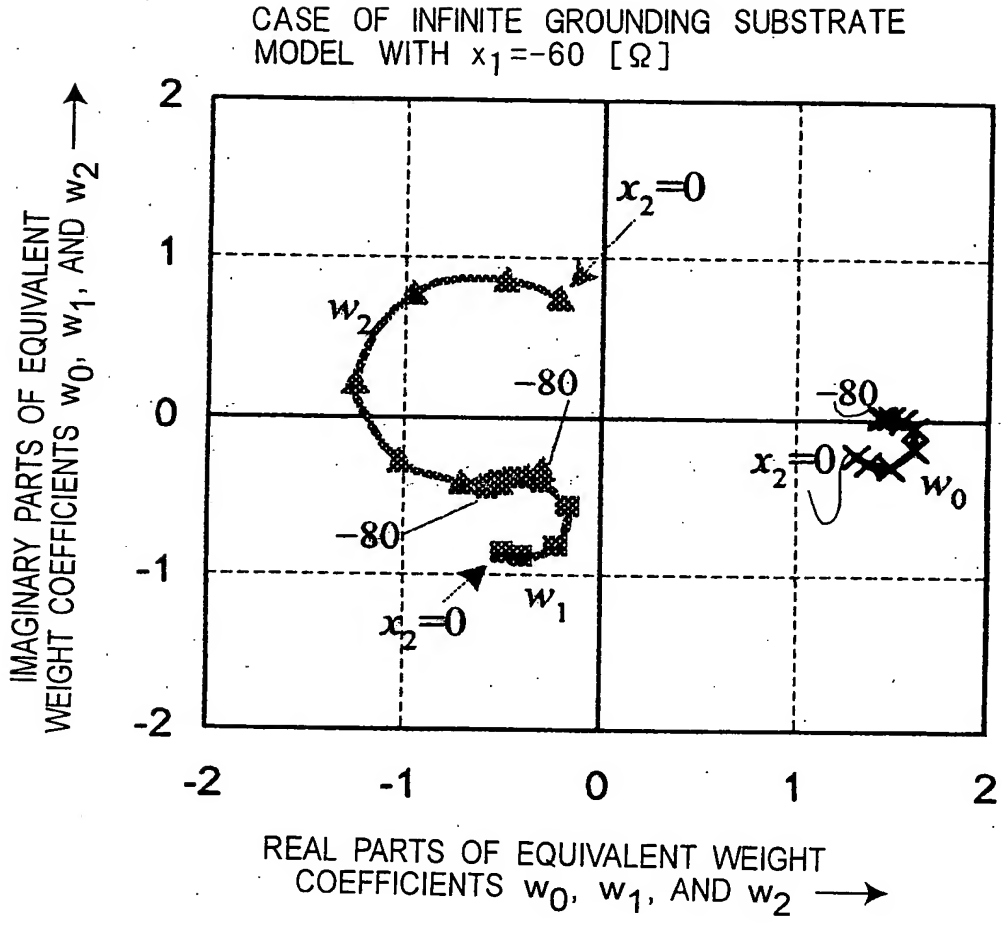

CASE OF INFINITE GROUNDING SUBSTRATE MODEL WITH x_1=-60 [Ω]
IMAGINARY PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
REAL PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
x_2=0
w_2
-80
-80
x_2=0
w_1
-80
x_2=0
w_0
2
1
0
-1
-2
-2
-1
0
1
2

Fig.46

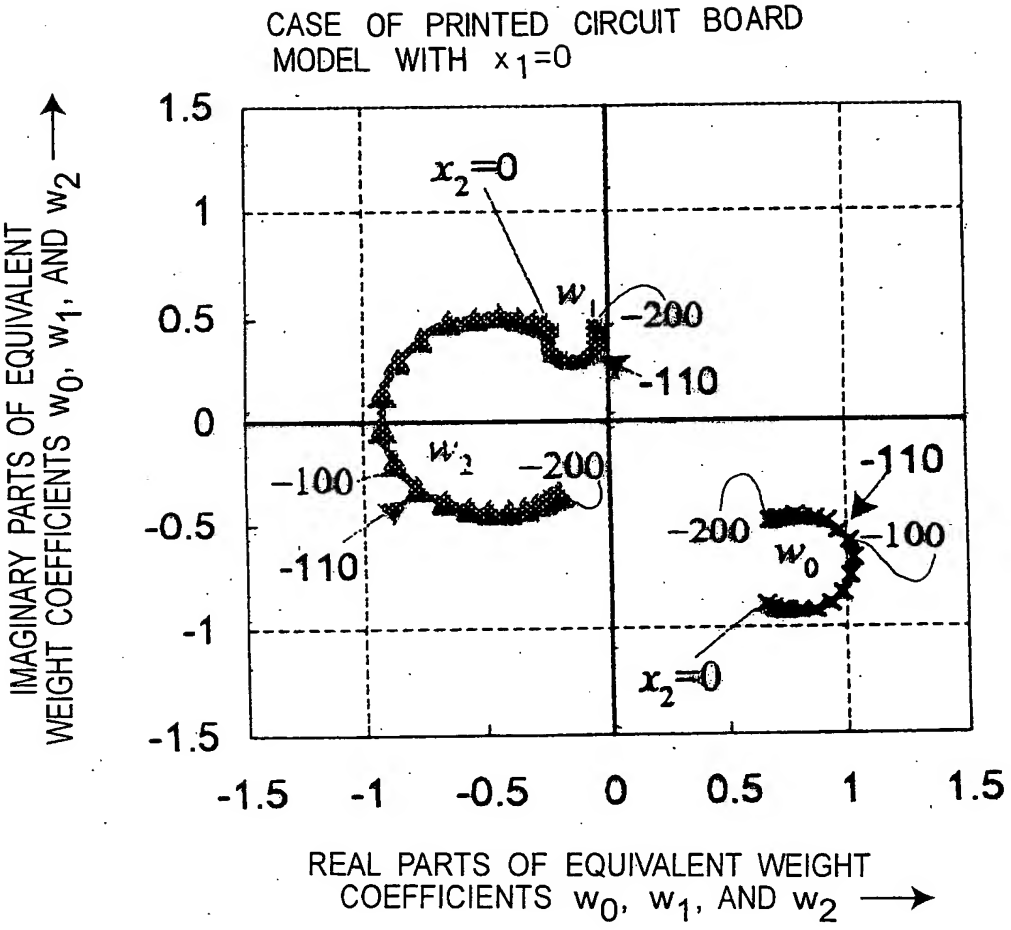

CASE OF PRINTED CIRCUIT BOARD
MODEL WITH x1=0
IMAGINARY PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w0, w1, AND w2
REAL PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w0, w1, AND w2
1.5
1
0.5
0
-0.5
-1
-1.5
-1.5
-1
-0.5
0
0.5
1
1.5
x2=0
w1
-200
-110
w2
-100
-200
-110
-110
-200
-100
w0
x2=0

Fig.47

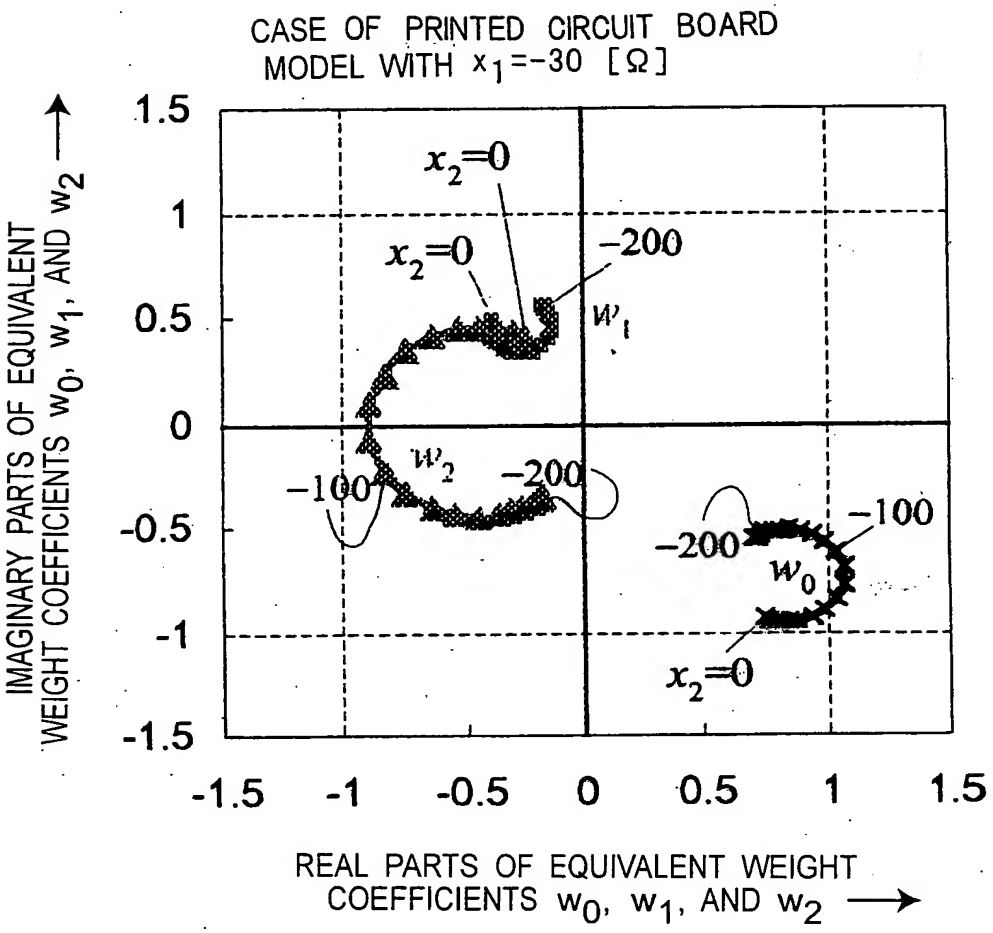
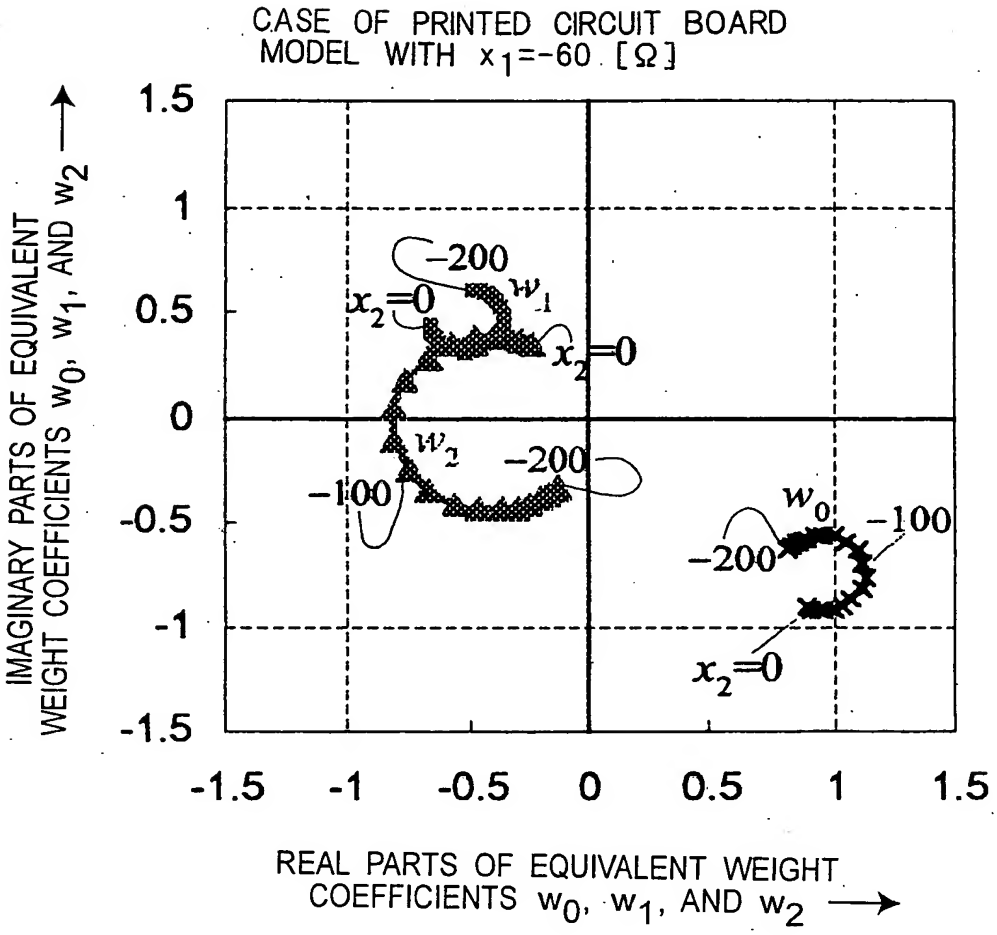

CASE OF PRINTED CIRCUIT BOARD
MODEL WITH x1=-30 [Ω]
IMAGINARY PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w0, w1, AND w2
REAL PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w0, w1, AND w2
1.5
1
0.5
0
-0.5
-1
-1.5
-1.5
-1
-0.5
0
0.5
1
1.5
x2=0
x2=0
-200
w1
w2
-100
-200
-200
-100
w0
x2=0

Fig.48


CASE OF PRINTED CIRCUIT BOARD
MODEL WITH x_1=-60 [Ω]
IMAGINARY PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
REAL PARTS OF EQUIVALENT WEIGHT COEFFICIENTS w_0, w_1, AND w_2
1.5
1
0.5
0
-0.5
-1
-1.5
-1.5
-1
-0.5
0
0.5
1
1.5
-200
w_1
x_2=0
x_2=0
w_2
-200
-100
w_0
-100
-200
x_2=0

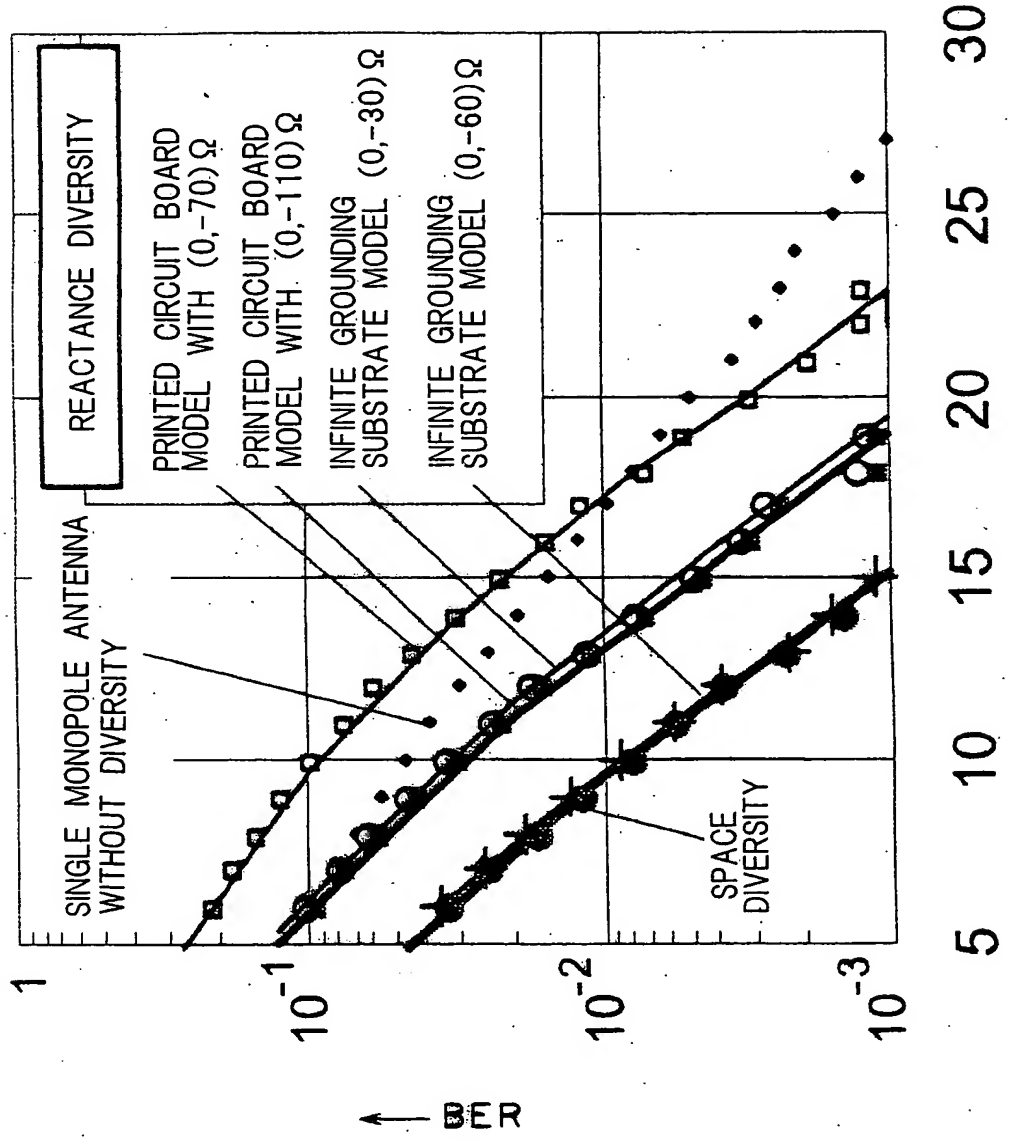

REACTANCE DIVERSITY
PRINTED CIRCUIT BOARD MODEL WITH (0,-70) Ω
PRINTED CIRCUIT BOARD MODEL WITH (0,-110) Ω
INFINITE GROUNDING SUBSTRATE MODEL (0,-30) Ω
INFINITE GROUNDING SUBSTRATE MODEL (0,-60) Ω
SINGLE MONOPOLE ANTENNA WITHOUT DIVERSITY
SPACE DIVERSITY
1
10^{-1}
10^{-2}
10^{-3}
← BER
5
10
15
20
25
30
AVERAGED E_b/N_0 [dB] →

Fig.49

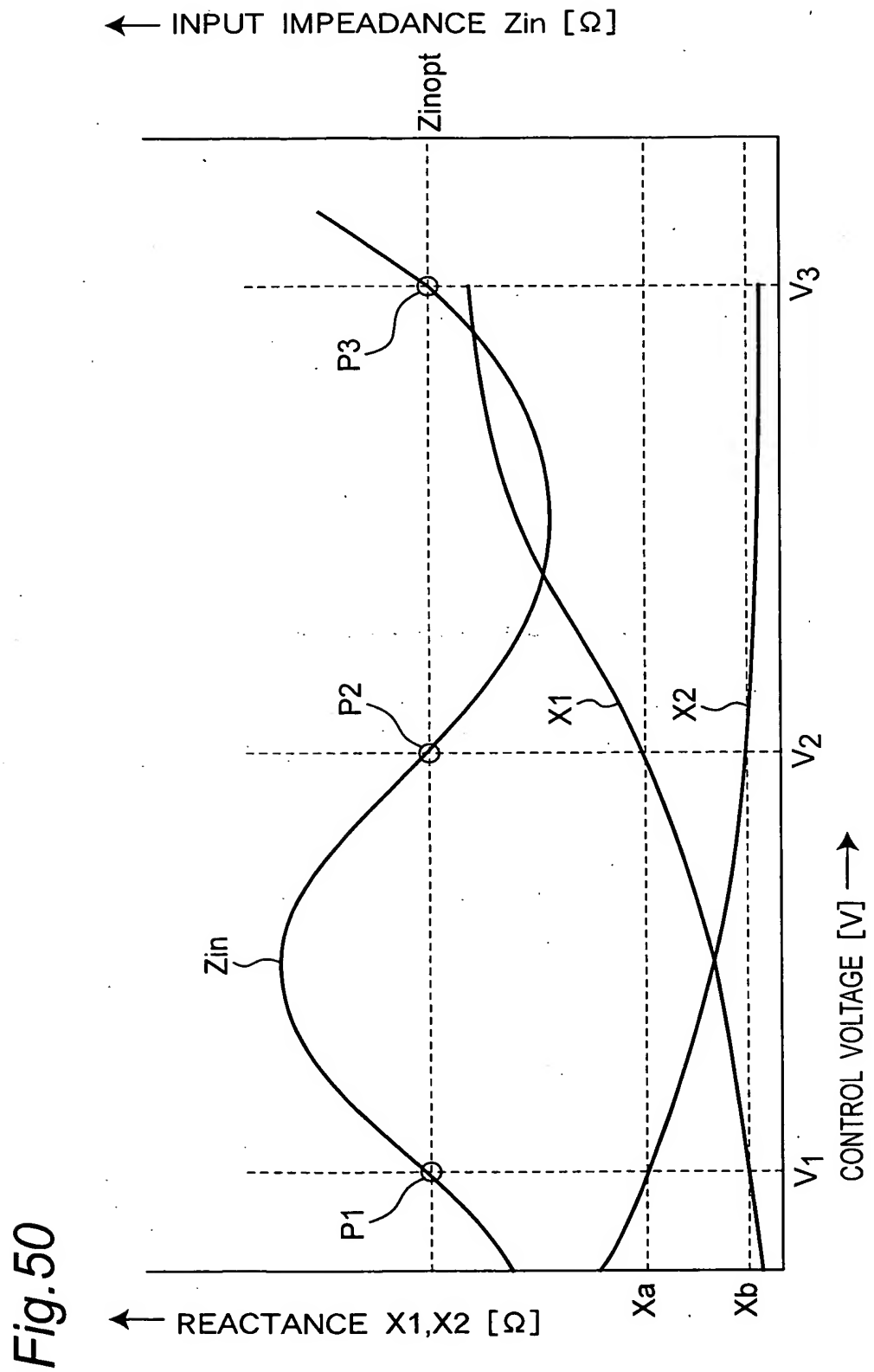

← INPUT IMPEADANCE Zin [Ω]
Zinopt
P3
P2
P1
Zin
X1
X2
V3
V2
V1
CONTROL VOLTAGE [V] →
Xa
Xb
← REACTANCE X1,X2 [Ω]

Fig.50

Fig.51

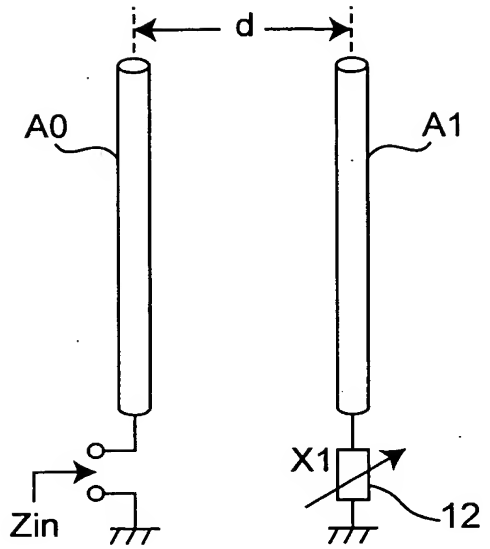
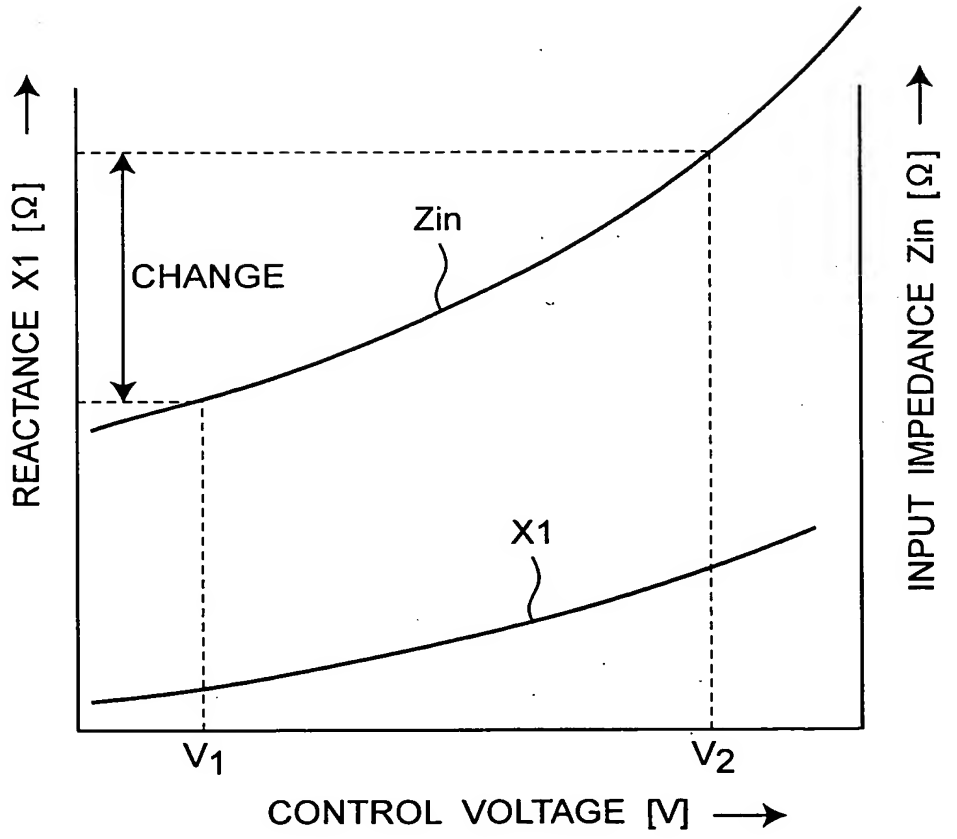

d
A0
A1
X1
12
Zin

Fig.52


REACTANCE X1 [Ω]
INPUT IMPEDANCE Zin [Ω]
CHANGE
Zin
X1
V1
V2
CONTROL VOLTAGE [V]